SUBSCRIPTION RATES:

The Annual Subscription, post free, to any part of the world is 21/- (English) or its equivalent in other currency. The price of single copies is 1/6, or 1/9 if sent by post. Back numbers (when available) are charged double if over six months old.

CONTRIBUTIONS:

All Letters and Contributions intended for Publication should be addressed to:—
K. R. DOGGETT, Editor,
"The Dock and Harbour Authority,"
19, Harcourt Street, London, W.1.
Telephone: PADdington 0077/8.

The Dock & Harbour Authority

No. 338. Vol. XXIX. DECEMBER, 1948

CONTENTS

Editorial Comments

Stornoway Harbour.

The seaport and borough of Stornoway in the Island of Lewis, is situated 180 miles North-West of Oban and is the chief town of the Outer Hebrides, with a population of about four thousand.

The Hebrides comprise a group of islands on the West Coast of Scotland which are usually divided into the Inner and Outer Hebrides, the two groups being separated from each other by the Minch. There are 500 islands in the two groups with a total area of 2,800 square miles but only about 100 are inhabited.

The Port of Stornoway, although not a large one, plays no inconspicuous part in our economy. During the last two wars it became an important naval base and in peace-time some 1,500 vessels use the port facilities in a year, while the fishing fleet engaged in those operations for some nine months of the year numbers as many as 250 to 300 vessels.

It is therefore with considerable pleasure that we are able to devote some space to an article upon the Port, which describes the present port facilities and an extensive post-war reconstruction programme which the Stornoway Pier and Harbour Commission decided in 1946 should be put in hand. The object of the scheme is to provide a sufficiency of quays with ample depth of water alongside, together with up-to-date facilities and a slipway for the repair of fishing craft.

The total cost of the proposed works, some of which are already in course of construction is not disclosed, but it is obvious that a considerable sum of money is to be expended upon the modernization of the port facilities which will go far towards the elimination of the present lack of accommodation and the inconvenience and delays to shipping experienced under the prevailing conditions at the harbour.

Coast Protection.

In the November issue of this Journal we published the first instalment of an article on Coast Protection by Mr. R. R. Minikin, the second instalment follows in the present issue, while we also publish in brief some of the main provisions of a Coast Protection Bill introduced in the House of Lords last month on behalf of the Minister of Health.

In the opening remarks of his article, Mr. Minikin drew attention to the unsatisfactory state of affairs obtaining in the past in respect to Coast protection work involving lack of co-operation, financial difficulties, inadequate technical consideration and the like and although a certain increase of co-ordination had been apparent recently between Boards and Owners of lands, the new Bill should enable the question of coast erosion and protection to be considered on broader local principles as well as upon a national basis.

Under the provisions of the Bill the County Boroughs and District Councils will be the protection authorities, and orders may be made for the constitution of Coast Protection Boards, to consist of representatives of the local authority, and other bodies concerned, for example a Fishery Board and the British Transport Commission. Boards will have power to raise money for protection work and to hold land, while certain protection work may have to be paid for in whole or in part by contribution by the owners of "contributory lands."

Notices of proposed work must be published and local enquiries held to hear objections and so on.

County Councils will contribute to the cost of work in the Counties and there will be also exchequer grants.

It will be with considerable interest that the working of the final Act of Parliament will be followed, and we hope that those directly concerned with coastal erosion and protection will find the difficulties they experienced in the past largely resolved by the new legislation.

Bascule Bridge at Port of Sunderland.

On a following page appears an account of the opening and construction of a new bridge at the Port of Sunderland which became necessary in order to span the junction between the Hudson and Hendon Docks, which has been widened as part of an extensive improvements scheme at present in hand.

There are several factors which make this event one of outstanding interest, firstly, its technical significance in the use of aluminium alloys in the construction of a bridge of this type, secondly, as an engineering project it is certainly one of the great achievements of the day, while thirdly, its relation to the country's export drive by advertisement of a specialist application of the use of new metal alloys for bridge work, is of considerable importance.

The new junction above referred to is half as wide again as the old one and a bascule bridge was decided upon in lieu of perpetuating the swing bridge type with its large and increased space requirements.

The use of aluminium alloys in the construction of the bascule leaves has resulted in their being 40 per cent. of the weight of equivalent steel structures, which naturally has reduced fabrication and erection costs and will further result in lower operating costs by reason of less power being required and lower maintenance expenditure. A feature of the construction of the bridge was the necessity for maintaining ship communication between the two docks, i.e., through the junction or passage and it was due to the lightness of the bascule leaves that it was possible to fabricate each

Editorial Comments - continued

leaf complete at the maker's yard and float them into position in motor craft.

The technical details and photographs accompanying the article describing this new method of bridge construction merit close study and examination by all whose interests may lie in the possible use of aluminium alloys for structural purposes, particularly Dock Authorities whose bridges are mostly of a movable type in which savings naturally would be more pronounced. Moreover the development of this alloy material will be followed with interest for there are many structures in dock undertakings to which a light material with little propensity to corrode would seem to be particularly applicable, for example, lock gates and floating or sliding caissons.

It will have been observed that the bridge described is part of a scheme of improvements in the port, actually there have been a number of developments in the Port of Sunderland since 1942, when the last descriptive article appeared in this Journal and we hope to refer to them in detail in a following issue.

Dock Amenities and Labour Disputes.

Mention was made in our Editorial columns recently that on the recommendation of the Ministry of Labour, the National Dock Labour Corporation had decided to prepare a survey and report upon dock amenities in all the ports of the United Kingdom.

We have been informed that investigations are proceeding at the North East Coast ports, and that representatives of dock and railway authorities, stevedores and other employers together with those of the trade unions concerned will report upon existing amenities and make recommendations for their improvement which will be finally examined and discussed in London by the National Dock Labour Board prior to their report to the Minister of Labour.

The underlying motive in this survey of dock amenities is the hope that improved conditions for dock workers will tend to reduce unofficial strikes and stoppages of work.

While it is generally admitted that attractive working conditions, adequate canteen and rest centres and so on are all of assistance in promoting a contented labour force, it must be conceded that up to the present most stoppages of work have been the result not so much of dissatisfaction with working conditions, but in respect to grievances largely connected with hours of work, rates of pay, the enforcement of disciplinary measures upon certain men alleged to have committed irregularities, and in some cases, to dislike of certain forms of mechanisation.

It is agreed that at some ports working conditions and amenities could be improved with advantage, but some authorities are unconvinced, however perfect and costly improvement schemes may be, that they will result in reducing the number of disputes and stoppages.

We are of opinion, while it is desirable that care and attention should be bestowed upon bringing working conditions and amenities up to an adequate standard of perfection, that the reasons for disputes and work stoppages are more deeply seated and psychological, that is to say less obvious than is generally supposed.

The dock strike in France following closely upon that in the coal mines may be politically inspired with a wages claim in the forefront, the strike in the East Coast Ports of the U.S.A. appears to be due to a wages dispute, while in this country we have recently had an unofficial strike in London, the grounds of complaint being apparently that the use of new fork lift trucks reduced the number of men required for a particular part of a ship-unloading operation.

On another page we publish an article by Mr. G. B. Lissenden upon the subject of mechanisation generally which brings forward certain aspects of this matter, and while we do not necessarily associate ourselves with all this writer has to say, we agree that education and training of dock workers is an aspect to which attention must be directed.

We cannot help thinking that in the background amongst the older men at any rate is a rankling recollection of the conditions of the bad old days in which is probably to be found one of the reasons for a dislike of any mechanisation which outwardly appears to be a means for the employment of fewer men for any particular operation and a corresponding increase in profit to the employer.

It should not be difficult to show that far from reducing the overall number of men required at ports through a judicious and scientific use of up-to-date plant, mechanisation should be capable of increasing the existing dock workers' wages by mechanical dexterity instead of by physical exhaustion, and that by turning ships round quickly, the more frequently will the ships return to port with consequent benefit to all concerned.

Further grounds for discontent may be an antipathy to the high rate of Income Tax and even to P.A.Y.E. in its present form, for many of the men have not yet fully grasped the social obligations which are involved in the payment of Income Tax, in connection with which they are apt to forget the State benefits which they now receive in return.

In conclusion, we would say that given good working conditions and amenities the ultimate solution to the reduction of unofficial dock labour disputes is to rid the force of subversive elements, to educate the men to a realisation of the importance of their work to the community; not only in respect of the problem of world recovery, but also for the attainment of a rising standard of living; to introduce some modification in the system of P.A.Y.E.; and finally to a reduction of the high incidence of both direct and indirect taxation.

Panama Canal.

In the November issue of this Journal, was published an abridged paper by James H. Stratton, M.A.S.C.E., from the Proceedings of the American Society of Civil Engineers. This is followed in this issue by précis of eight other papers written by the engineers engaged upon the investigations and research in connection with the means of improving the capacity and security of the present Panama Canal or by its conversion into a sea-level canal.

The précis are necessarily severely restricted owing to space considerations but they present, even so, a comprehensive review of the basis of the research, the methods of study adopted and the many and various technical and engineering features of the investigations which centre around the scheme for the conversion of the existing canal into one at sea-level throughout its entire length.

One of the more interesting papers to an engineer is that entitled "Construction Planning and Methods," in which dredgers of great size are contemplated for the prosecution of the deep-dredging single stage scheme, but we hope that in all the précis will be found, subject matter of importance and interest not only to engineers but to our readers generally.

Women Customs Officers

The Commissioners of Customs and Excise have recently approved the employment of a number of women officers for searching women passengers and women members of crews arriving from or departing to foreign countries.

All passengers and ship's crews are liable to search of the person in connection with the detection and control of smuggling, and up to the present time various women officials of other services such as women police officers, wardresses, nurses, etc., have been employed on a casual basis for searching women at the ports.

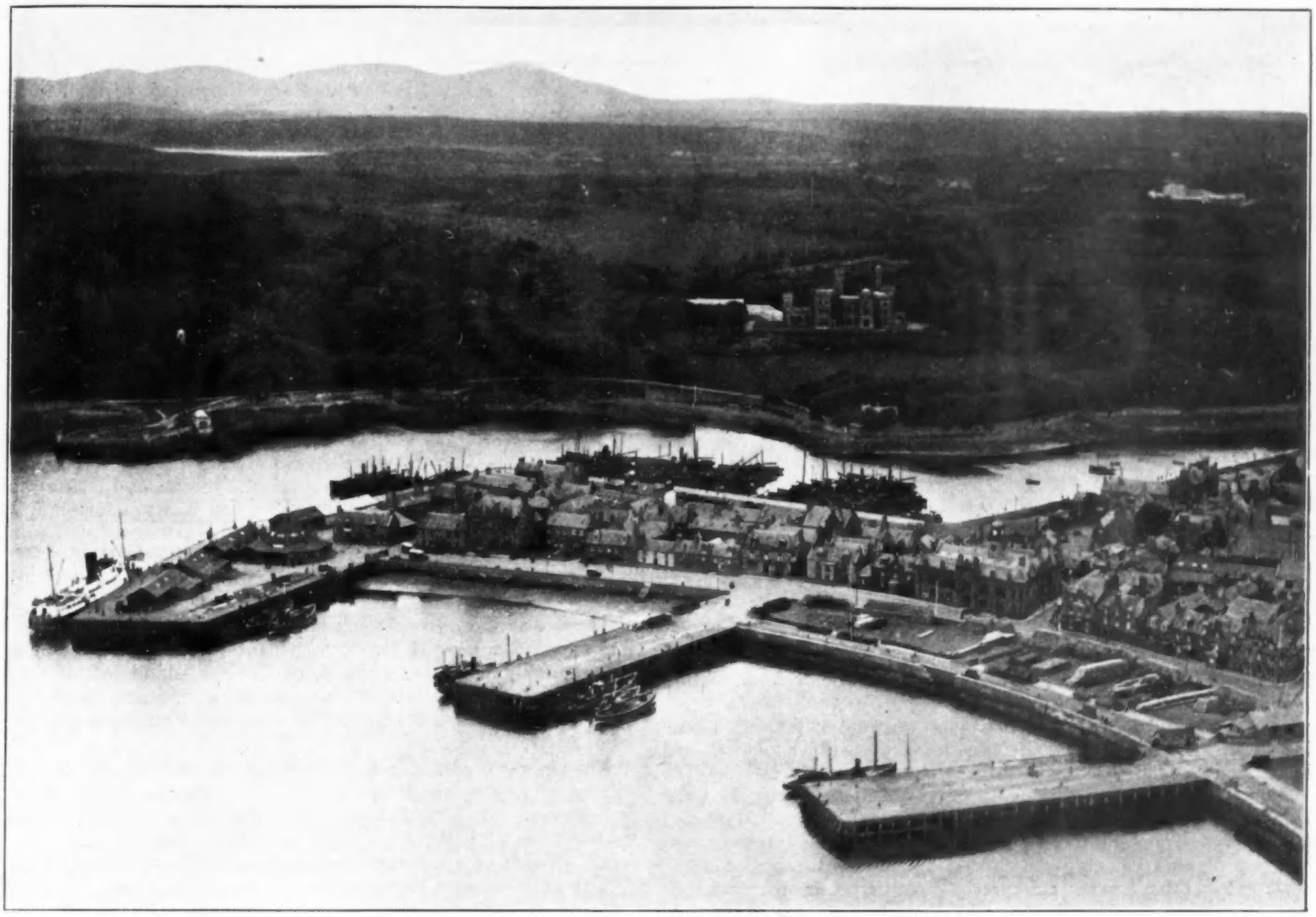
The Commissioners have now decided, as an experimental measure, to employ for the first time a specially recruited staff of women search officers for this and other Customs preventive duties.

A number of women clerical officers now serving in the Customs and Excise Department, have already been selected for these duties, have received their initial training and have been given instruction in the technique of personal search by an experienced woman police officer from Scotland Yard.

The women search officers will be Customs officers with full authority to perform duties under Customs law and will hold commissions similar to those held by the male Customs officers.

The uniform to be worn by the new staff will be on the lines of the W.R.N.S. officers' uniform, but with the distinctive Customs buttons and cap badge.

We feel certain that this innovation will fill a deficiency which was beginning to be acute and that it should bring the Customs and Excise arrangements at ports to a high standard of efficiency.



Aerial view of the Port of Stornoway.

Stornoway Harbour

Commercial and Fishing Port in Outer Hebrides

[Specially contributed.]

Introduction

THE Port of Stornoway, in the Island of Lewis in the Outer Hebrides, besides being the only commercial port for the island, is also an important fishing centre, being used by fishing vessels from practically all the herring fishing ports in Scotland, and a large number of those in England, during the winter and spring fishings. It also draws some importance by reason of it being the most north-westerly port in the United Kingdom, and as such, is frequently resorted to by mercantile shipping for bunkers, etc.

The fine natural harbour is situated at the head of a deeply indented bay and is sheltered from all winds. It is bounded to the seaward by a line between Holm Point and Arnish Point, and covers an area of approximately two square miles. It is land-locked and the entrance is easy, permitting large vessels to reach the shelter of the Outer Harbour in any state of tide or weather. It has good anchorage and in very stormy weather it is frequently used as a harbour of refuge.

The port has facilities for both coal and oil refuelling, and possesses up-to-date berthing accommodation, and during the war of 1914-18 and also the recent war it was used extensively as a naval base.

History of the Port and Harbour

As a port, it has a long history. Nobody knows exactly how long. Somebody once said that its founder must have been some sea rover with a good eye for a refuge from the storm and peril of his calling. Certainly during the 17th century the prolific fishings in the surrounding waters were prosecuted energetically, not only by local inhabitants but also by the Dutch, some of whom even emigrated to the island on the invitation of the Earl of Seaforth. It could boast in the last century of a shipyard, which built many fine ships which were engaged in trade, especially with the Baltic, Scandinavia, Holland and France. With the disappearance of the sailer, ousted by steam, the shipyard went into desuetude.

As a harbour it dates from 1864, when Sir James Matheson, Bart., then the proprietor of the island, formed the Stornoway Pier and Harbour Commission and conveyed to them the port facilities then existing, together with additional land for harbour development. The Harbour Commission was later, in 1865, incorporated under the Commissioners Clauses Act by a Provisional Order, conferring upon them the usual powers for levying dues and undertaking developments. The powers were extended by subsequent Provisional Orders in 1881, 1892, 1926 and 1947. The Commission consists of ten members, publicly elected annually.

Stornaway Harbour—continued

Shipping at King Edward Wharf prior to extension.

Present Port Facilities

The Inner Harbour, which has a quayage of 1,600 ft. with a depth of water at low-tide ranging from 8 to 13 ft., is comparatively sheltered at all times, but can only be used for the accommodation of the smaller class of fishing craft.

The Outer Harbour is provided with three wharfs along a portion of its northern side. Esplanade Quay with King Edward Wharf, into which it extends, have a frontage of about 1,300 ft., with a depth of water ranging from 13 to 20 ft. King Edward Wharf is in the course of being extended by 300 ft. seaward. No. 2 Wharf has a frontage of about 760 ft. Considerable improvements on the foregoing wharfs were carried out during the period 1930-1937, when they were completely reconstructed in reinforced concrete at a cost of £120,000. These improvements resulted in the facilities at the port being rendered more efficient, but did not greatly increase the accommodation, except at No. 2 Wharf, the reconstruction and extension of which increased the accommodation for certain classes of traffic. No. 3 Wharf, a timber structure to the eastward of No. 2 Wharf, which has been in use for over half a century, is now derelict and is in course of demolition.

Post War Reconstruction Scheme

In view of the limited accommodation and the inconvenience and delays to shipping traffic experienced under the prevailing conditions at the harbour, the Stornoway Pier and Harbour Commission decided in 1946 to proceed with a scheme of harbour development designed to provide a sufficiency of quays with ample depth of water alongside and facilities for the repair of fishing craft.

As already mentioned, the whole of the quays and wharfs have a comparatively shallow depth alongside and, having regard to efficiency and economy, the most satisfactory site for additional berthage with deep water was to be found by the extension of the King Edward Wharf.

It was therefore decided to extend this wharf for a length of 300-ft. The extension takes the form of an open piled structure. The heavy reinforced concrete deck is carried on 18-in. by 16-in. R.C. piles varying in length from 50 to 60-ft. raker piles being introduced to develop the necessary lateral stiffness in the structure, the whole being protected by a system of timber fendering. The necessary water and electric services will also be provided. The lines and dimensions of the extension are shown in Feg. 1.

In view of the geographical position of Stornoway, it was most desirable in the interests of all concerned that all types of fishing craft should, in case of emergency while in waters to the north and west of Lewis, be able not only to take refuge at Stornoway, but also be able to effect urgent temporary repairs without facing the risk of a difficult and stormy passage to other ports at considerable distance.

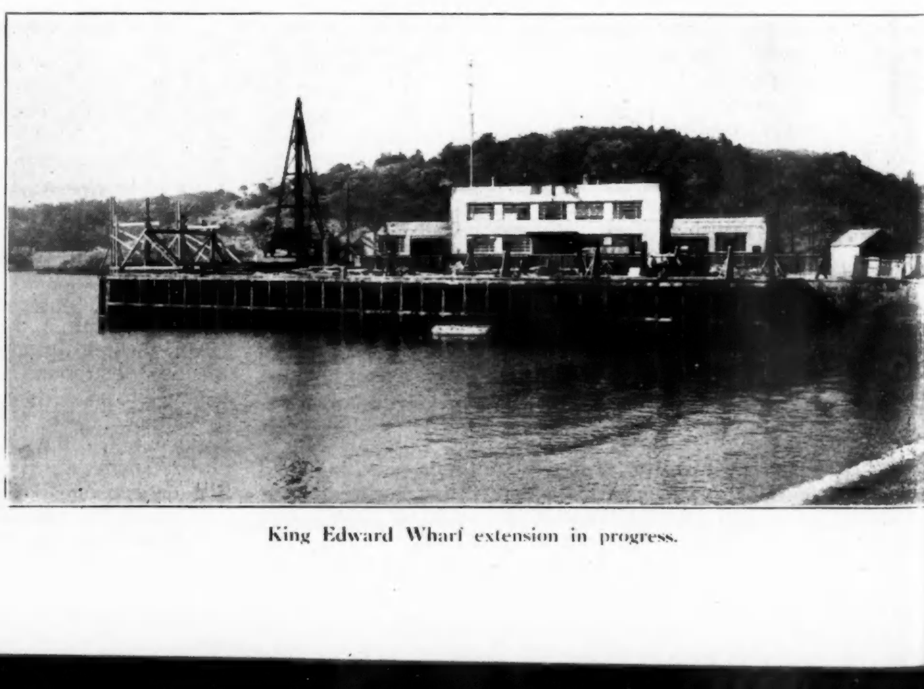
In order to provide facilities for the repair of fishing craft, it was decided to develop the Goat Island site. This is a small island in the Outer Harbour, having an area of 2.2 acres and lying about 370 yds. from the Newton foreshore. In order to make the best use of this area, it was decided to reduce the level of the island to a uniform height of 6-ft. above H.W.O.S.T., leaving a " Berm " 6-ft. high along the south side.

The excavation from the island is to be deposited along the line shown on Fig. II. to form a causeway, having a length of 1,430 feet, joining the southern end of the island to the Newton foreshore. The material to be excavated consists for the most part of a fairly hard conglomerate of boulders embedded in a very firm matrix.

The depth of soft material overlying the rock on the site of the causeway is very small and over a considerable length the rock is exposed at L.W.O.S.T. The maximum depth of water encountered at L.W.O.S.T. is 6 to 8 feet, and this only extends over a length of approximately 250 lineal feet of the causeway.

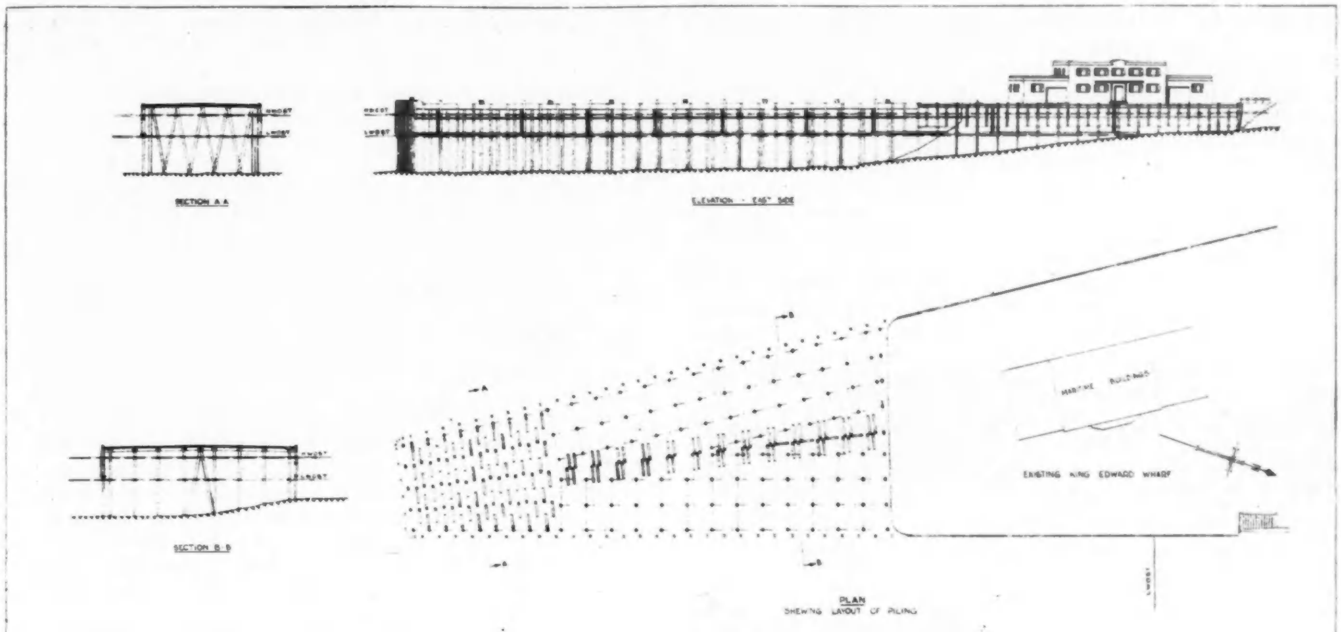
The embankment forming the causeway will have a slope of 1 in 4 on the seaward side, to form a spending slope to dissipate wave action. The slope on the landward side will approximate to the natural slope of the material as deposited. The seaward face will be protected against erosion by depositing thereon a layer 2-ft. 6-in. deep of broken rock, each fragment weighing from half a ton to two tons and over. This layer will further assist in dissipating wave action and prevent sea washing to a height much above the level of High Water.

The quantity of material available being limited, it will probably only be sufficient to form an embankment with a top width of approximately 27-ft. 6-in. A carriageway having a width of



King Edward Wharf extension in progress.

Stornaway Harbour—continued

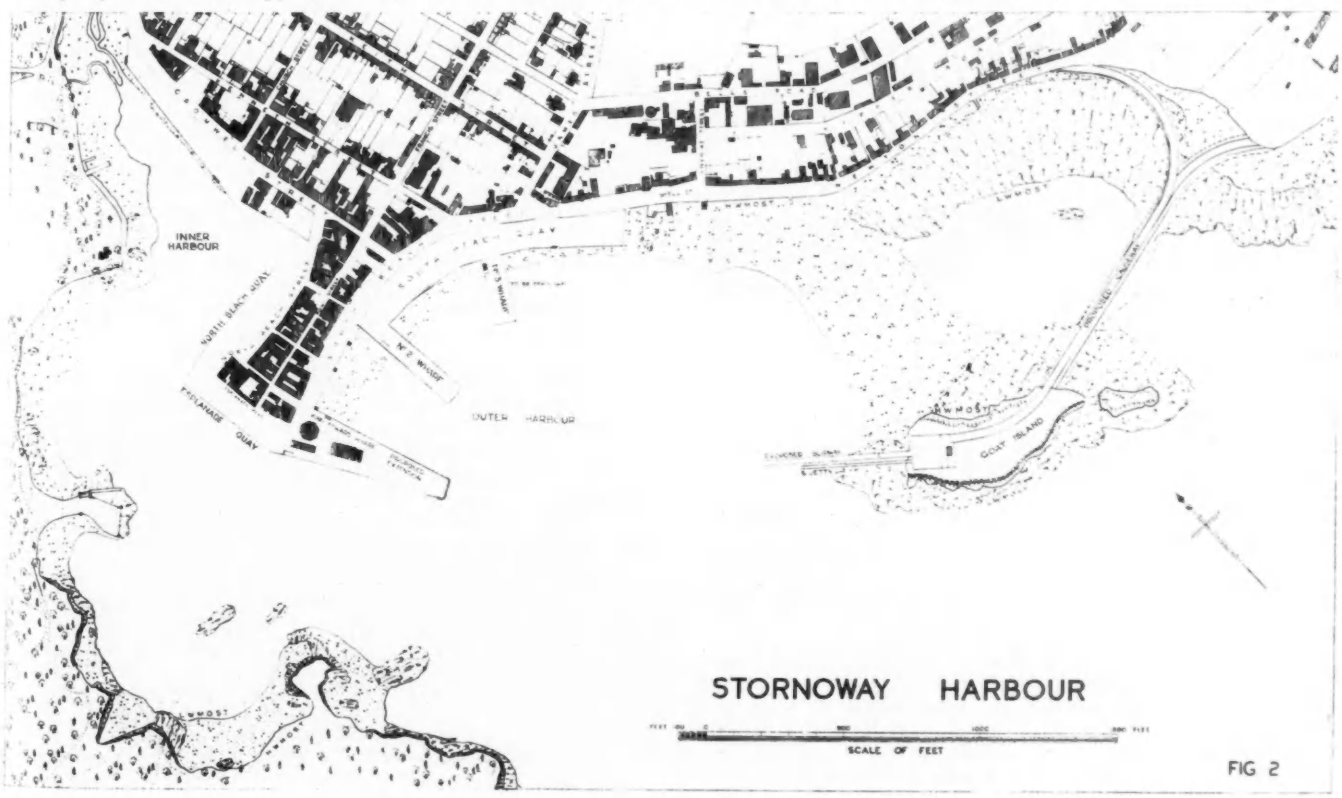


STORNOWAY HARBOUR
EXTENSION OF KING EDWARD WHARF

FIG. 1

20 feet will be provided, together with a pavement and concrete wall along the seaward side. A water main will be laid along the embankment, together with ducts for electric power and lighting cables, lighting standards being installed at 150 foot intervals throughout the length of the causeway.

A slipway with side slipping arrangements similar to those installed at Fleetwood, Hull and Grimsby, is to be constructed on Goat Island in the position shown on Fig. II. The hydrographic survey of the area has shown that this site gives a favourable ground slope closely approximating to that of the slipway. The depth of water is sufficient to permit of the largest size of herring drifters being slipped at any state of the tide and large



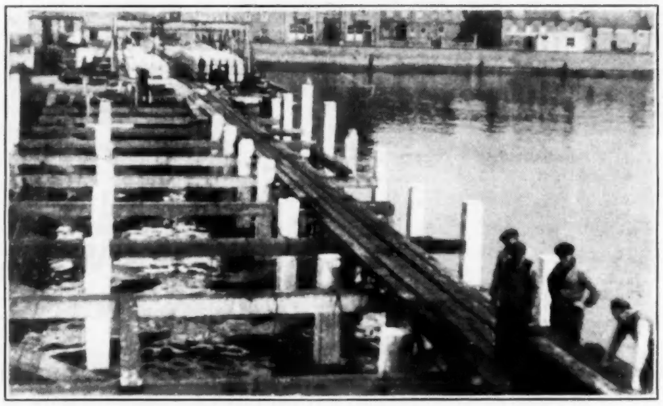
STORNOWAY HARBOUR

FIG 2

Stornaway Harbour—continued

size trawlers at half tide. The main slipway will have a gradient of 1 in 13.75 and a length of 450 feet, and will be capable of accommodating vessels with a displacement up to 750 tons. Two side berths will be provided in the slipway yard, one on either side of the main slipway, to accommodate fishing craft with a displacement up to 200 tons.

The cradle consists of nine separate carriages constructed of steel, each carriage being mounted on twelve double flanged cast steel rail wheels, 13 inches in diameter, with gun-metal bushes and forged steel axles. The carriages are connected by detachable steel links, which can be swung clear when required. These links are also provided with hinged braces, and when connected up on one or both sides of the cradle enable all the cradle and traverser carriages to be pulled over by the traversing gear.



Extension to King Edward Wharf under construction.

Pile driving for King Edward Wharf.

The traverser in this instance consists of six separate steel carriages, each mounted on centre flanged cast steel wheels, 13 inches in diameter. These carriages run on rails laid at right angles to and below the level of the main slipway rails. In each traverser carriage there are two locking bars to lock the cradle in position when traversing, and each carriage is surmounted by longitudinal rails which correspond with the main slipway rails and register with them. The rails upon which the cradle runs over the upper part of the slipway thus consist of portions of longitudinal rails on the traverser carriages when they are in the central position and short intermediate lengths of fixed rails carried on suitable foundations between the traverser carriages.

The main haulage winch and traversing machinery will be electrically operated, and electric power and light together with water services are being provided on Goat Island.

A jetty having a deck width of 10 feet at the outer end is to be provided on the west side of the slipway, which will give protection from wave action during westerly or south-westerly winds and will greatly facilitate slipping operations. The jetty is of reinforced concrete construction carried on mass concrete foundations, which are brought up to 3 feet above L.W.O.S.T.

The designs for the 300-ft. extension of the King Edward Wharf were prepared by the late Arch. Henderson, Esq., M.Inst.C.E., M.I.Struct.E., and the work is now being carried out under the supervision of the Consulting Engineers, Messrs. Arch Henderson & Partners, the contractors being Messrs. Christiani & Nielson, Ltd., London. It is anticipated that work on the remainder of the scheme will be put in hand early next year.

The Fishing Industry

The number of ships, other than fishing vessels, entering and leaving the harbour in the course of a year is in the region of 1,500; while the number of fishing boats operating from the port varies in number up to as many as 250-300. The port is in the fortunate position—not enjoyed by any other herring fishing port in Britain—of having a catching season aggregating about nine months of the year. Although the falling off in herring curing, which was operated on a very large scale in Stornoway in years gone by, has limited in some measure the prosecution of the herring industry, the Harbour Authority is confident that the new processing methods now being introduced by the Herring Board will go far to restore Stornoway to the position of eminence as a herring fishing port which it formerly held; and it is in full confidence of this that the present schemes of development are embarked upon, fortified by the verity of the town's motto: "God's Providence is Our Inheritance".

Portuguese Maritime Engineering

The construction and maintenance of Harbour works and Coast Protection of Portugal and some of her colonies devolves upon the Directory of Hydraulic Services, of the Ministry of Public Works and Communications. Included in this Directory is the department of Maritime Engineering under the control of Dr. Raul G. V. de Campos de Carvalho. The Engineer-in-chief of the Hydraulic Services is Dr. Duarte Abecasis under whose able direction remarkable progress of engineering technique and efficient construction has taken place in the past ten years. A record of this activity is published in the weighty volumes of Reports issued by the Ministry. That concerned with the Maritime section is particularly interesting and shews the great diversity of the problems dealt with during the last few years. Not only do the reports deal with the technical operations but they also include, where of useful import, the relative effect of new works upon the economy, or hazard, of the immediate locality. For example, tables are given of the number of vessels, and their tonnage, using a harbour over the period parallel with dredging or constructional improvements. They also shew the number or value of wrecks or accidents occurring in a harbour precincts over the periods related to the progress of improvement operations. This latter matter is also related to the atmospheric conditions. Much research work and many surveys have been carried out with a view to improving the continental harbours, large and small, and one very complete report is given of the small harbours of the Madeira Island group, where the main transporting system is sea-borne.

Dr. Abecasis has instituted a comprehensive scheme of research into coast protection and beach maintenance, particularly related to the defence of the smaller fishing villages clustered on the coastal fringe of the Atlantic.

The report also shews that schemes are in hand for the construction of Dry Docks at Viana do Castello, and the extension and widening of the breakwater from the Custom House Quay at Funchal. It is proposed that this extension will allow of deep-sea vessels coming alongside the quays instead of lying off shore to discharge their passengers and cargo into launches and barges. Provision is to be made on the proposed quay for the construction of four large warehouses.

G.A.C.

The Panama Canal

Examination of the Sea-Level Project

(Continued from page 164)

The précis which follow are of papers written by American Engineers who were engaged upon the work of investigation and research conducted under powers given by Congress of the United States of America for the purpose of determining the best means of improving inter-oceanic sea communications, with special reference to the possibility of increasng the capacty of the present Panama Canal or by its conversion into a sea-level canal.

1—Traffic and Capacity

By RALPH P. JOHNSON and SYDNEY O. STEINBORN (Assoc. Members, A.S.C.E.).

This Paper details the investigations and studies conducted by Professor Kramer of the University of Pennsylvania, who had been engaged as Traffic Consultant.

The capacities of the present Panama Canal, of two improved Panama lock canals, and a Panama sea-level canal, were all analysed. All the calculations were based upon certain assumptions, such as that there would be no widespread wars taking place within the period covered by the forecast, and normal development of trade. Moreover the effects of unforseen changes in the sciences, such as atomic energy and air transport, were not appraised.

Past traffic was found to have been evenly divided as to direction. The time interval between successive lockages in the same direction is 45 minutes in the present canal. Operating 24 hours per day under ideal conditions, the present locks can accommodate daily a total of 96 vessels.

Each lock structure is overhauled once every four years and takes four months, during which period only one lane of locks is available and the lock capacity is reduced to 39 vessels.

Until World War II, the lock chamber dimensions of the present canal were accepted as a limitation in design of naval vessels, but several warships constructed during the war exceed the dimensions of the present locks. The proposed lock chamber dimensions of 200 feet by 1,500 feet, for either a high-level lock of a lock canal or the tidal lock of a sea-level canal, would permit transit of the largest commercial vessels expected to be built up to the year 2,000 and would allow a considerable increase in size of naval vessels. The 750 feet wide navigable pass would also be ample in size.

The capacity of either a lock or sea-level canal must be based on the frequency of fogs, which occur most frequently during the rainy season and generally between midnight and 8 a.m., and usually of an average duration of four hours. Loss of capacity during eight months rainy season per year is 32 vessels daily.

Complete modernisation of the present canal would provide for construction of two new locks (200 feet by 1,500 feet) at each end of the canal and abandonment of the existing locks; widening of the Gaillard Cut, permitting two-way navigation at night; raising of the Miraflores Lake to the level of the Gatun Lock, together with the construction of tie-up places in the Gaillard Cut.

With a time interval between successive lockages in the same direction of 57 minutes, the theoretical increase in capacity of the new locks would be 120 vessels daily.

The capacity of the proposed Panama sea-level canal depends upon the use of the tide-regulating structures. Shipping would use the tidal lock when the tidal head between the canal and the Pacific Ocean was large, and the navigable pass when the tides were at or near mean. The amount of tidal regulation necessary to limit the channel currents to the selected maximum value depends upon the range of Pacific tides (which subject is dealt with in the 4th Paper, on Tidal Currents).

The capacity of the channel again depends on safe vessel spacing and speeds.

Daily capacity of the tidal lock when solely in use, with an average time interval between lockages of 40 minutes, would be 86 vessels.

The capacity of the navigable pass, when solely in use, would give full freedom to flow of traffic. Daily capacity of the pass thus depends on the length of time it would be open for navigation and on the adopted vessel spacing, which varies from 1 nautical mile for no current, 1.5 miles for a current of 2 knots, and 2 miles for a channel current of 4 to 5 knots.

If the tidal regulating structures were operated to limit channel current of 2 knots, the pass would be open about 4.9 hours for each day having 20 ft. tides, daily capacity would then be 88 vessels. For a current of 4 knots with 20 ft. tides, the capacity would be 260 vessels daily.

In normal working, however, the navigable pass and lock would both be used. The 24 hours daily combined capacity with tidal regulation would be a total of 174 vessels, i.e., 86 vessels through the lock and 88 vessels through the pass. The capacity of the canal would be reduced, owing to fog, to 126 with 4 knot tides.

Without tidal regulation and with an average water speed of 10 knots, and with vessel spacing of 2 miles, the daily capacity would be 320 vessels. During fog, with a daily operation of 16 hours, the daily capacity would be 214 vessels.

At an average water speed of 10 knots, the time required to transit the sea-level canal without tidal regulation would vary from 3.3 hours to 5 hours.

2—Flood Control

By F. S. BROWN, Assoc. M.A.S.C.E.

The development of a Panama sea-level canal would require that shipping be protected by adequate control of floods on the major rivers and streams tributary to the canal.

Tidal ranges of 20 ft. in the Pacific, and 2 ft. in the Atlantic, would produce a current velocity of 4.5 knots near the Atlantic end of an uncontrolled canal, which figure was taken as the maximum which ships of adequate power and controllability could safely negotiate—any increase due to floods is therefore undesirable.

The effects of large floods on velocities in an uncontrolled canal were demonstrated in the hydraulic model of the sea-level canal by super-imposing the flood of December 26th to 30th, 1909.

The topography of the Panama canal area and the general steepness of the water sheds produces a rapid run off. Thickly forested areas also offer little deterrent to rapid run off, but in regions of less elevation there is less forest and more undergrowth, causing rainfall losses and a retarded run off.

The climate of the Canal zone has a distinct seasonal variation of rainfall, uniform air temperature, and high relative humidity. The wet season is from May through December. All major floods have occurred in the past during the last three months of the year.

The adopted plan of flood control embodies: (a) complete diversion of all run off from the major tributaries and (b) control by regulating reservoirs of several small streams entering the canal south of Gamboa. Nine per cent. only of the entire watershed would not be controlled. Fig. 6 on page 163 of the previous issue shows the location of the flood control projects.

The Madden Lake would be used in the proportion of 60 per cent. flood control and 40 per cent. for hydro-electric power. Regulated discharges would be released from the Madden dam to Gamboa reservoir, the outflow from which being diverted northwards via the Chagres River diversion channel to the Monte Liro reservoir.

The Panama Canal—**continued**

A 38 ft. diam. tunnel would be constructed for the diversion of the Chagres River during construction of the dam and would be retained for emergency releases of flood discharge into the sea-level canal in such a remote contingency as the closure of the open Chagres channel by slides.

Diverted flows would leave Gamboa reservoir through a 45 ft. tunnel, and thence through the open channel.

All flows from the Monte Liro reservoir would be diverted to Las Minas Bay, on the Caribbean Coast.

Discharge from the Cano Quebrodo reservoir would flow through an uncontrolled channel to the Trinidad reservoir; there would be a dam and spillway at the end of the latter, discharging to the old channel of the Chagres River to the sea.

Three small reservoirs with spillways—the Mandiga, Cocoli and Miraflores reservoirs—would discharge regulated flows direct to the canal.

Sound rock for foundations of all dams is found at reasonable depths, and no difficulties are anticipated in the construction of the open channels.

Hydro-electric power is now generated in the Canal zone at Gatun and Madden, and further plants are envisaged in the new sea-level and flood control scheme.

3—Tidal Currents

By J. S. MEYERS and E. A. SCHULTZ, Assoc. Members A.S.C.E.

A current of about 4.5 knots at the Atlantic end of the Panama sea level canal is estimated both by computations and by hydraulic model tests as the maximum that would be caused by a tidal range of 20-ft. in the Pacific Ocean.

The hydraulic model used for the experiments was constructed to an undistorted scale of 1 : 100. The entire length of the proposed 60-ft. x 600-ft. navigation channel was reproduced and also the Atlantic and Pacific entrances out to deep water. The complete model was about half-a-mile long.

The tides at the Atlantic and Pacific termini of the canal are very different both in magnitude and general character. The following table indicates the percentages of Balbao tides that have different ranges:—

Percentage of Total Tides.	Tidal Ranges (ft.).
2	20
20	16
50	13
80	10
99	6

At Cristobal on the Atlantic Coast extreme tides have reached 1.8-ft. above and 1.25-ft. below mean sea level. Mean tidal range is 0.9-ft. and the minimum practically zero.

Atlantic tides precede Pacific high tides from zero hours to 6 hours, averaging 3 hours.

Mean sea level on the Pacific side is 0.77-ft. higher than on the Atlantic side.

The computation of tidal velocities by both analytical calculations by different authorities and from the model experiments showed remarkable agreement.

In the sea-level canal when unregulated, the maximum velocity occurs at the opposite end of the canal from the strong tide that creates it, velocities in the canal varying according to depth and cross-section.

As the Pacific tide drops, the flow would slacken and then change direction. For a short period during the change, water would flow out of each end of the canal and then the flow through the canal would gradually increase to maximum strength towards the Pacific. A similar sequence of flows in the opposite direction would occur during the half cycle of 6 hours, while the tide returned to its starting point.

The current in the canal would always vary gradually and continuously with no abrupt differences and would change direction every 6 hours.

Tidal currents in the sea-level canal would, however, be regulated by the structures shown in Fig.4 (on page 161 of the last issue) to any desired limiting value between 0.5 knots and 4.5 knots.

The value of the 0.5 knot tide would be the current produced by the action of a 2-ft. Atlantic tide in a canal closed at the Pacific end and the value of the 4.5 knot tide would be that produced by the combination of 20-ft. Pacific and 2-ft. Atlantic tides in the open channel.

The pass would normally be closed when the tide was at high level or low level to exclude the entry of tidal flow into the canal which would cause currents in excess of the selected maximum value. Ships would use the tidal lock when the navigable pass was closed.

The velocities in an unregulated sea-level canal and the daily availability of the navigable pass in the sea-canal when regulated are shown respectively in Tables (2) and (3) on page 161 of the last issue.

4—Ship Performance in Restricted Channels

By C. A. LEE and C. E. BOWERS, Juniors A.S.C.E.

Exhaustive experiments and tests were conducted at the David Taylor Model Basin to obtain information which would be of assistance in the selection of the cross-sectional dimensions and design of bends.

The studies included:

(1) An investigation of the effect of varying the cross-sectional dimensions of the channel for both one-way and two-way traffic.

(2) The comparative handling characteristics of several different types of ships under various conditions.

(3) The effect of current in the channel on the handling characteristics of ships.

(4) A comparison of several types of bends.

Navigation in restricted channels or canals is difficult, not only because of the limited space available, but also because of various hydrodynamic phenomena that introduce additional hazards.

One of these phenomena is popularly described as " bank suction " which occurs when a vessel is closer to one side of the restricted channel than it is to the other side, and a similar result occurs when two vessels pass closer together than they are to the sides of the channel. The effect is to cause the vessel to shear or deviate from its original course, the bow being forced away from the near bank by the build-up of the water between the bow of the moving vessel and the bank and the stern of the vessel being forced towards the near bank by the water level dropping below its normal level as it flows aft along the sides of the vessel to fill the void left by the stern. The normal method of keeping the vessel on a straight course is naturally by careful steering.

Another hydrodynamic phenomenon that may be serious during the transit of a vessel through a restricted channel is the change in level of the vessel.

When a vessel is under way in shallow water or in a restricted channel, the water surface in the vicinity of the vessel drops below the normal level because of the increase in velocity of the water as it flows around the vessel which drops with it.

The ship may therefore touch bottom unless ample depth is provided.

The magnitude of this change in level is a function of the ship's speed, the dimensions and lines of the ship and the channel dimensions.

The studies of the behaviour of vessels in restricted channels used for two-way traffic sought to obtain information on the inter-action between two ships passing and between the ships and the channel boundaries.

When two vessels are meeting each other in a restricted channel there is a tendency for the water surface to build up between the bows forcing them apart. As the vessels draw abreast of each other, the bow of each vessel tends to move toward the low water surface in the vicinity of the stern of the other with the result that they then tend to " yaw " towards each other. When the sterns

The Panama Canal—continued

are almost opposite each other there is a tendency for the sterns to move towards each other thus reversing the direction of the yaw."

Superimposed on these effects is the effect caused by interaction between each vessel and the channel boundaries.

Such phenomena and means of overcoming them were exhaustively studied by models both for one-way traffic and two-way passing traffic, and by research into experiments already made and data prepared by former investigators.

As a result certain minimum dimensions for restricted channels were arrived at for use by vessels of various sizes and types. It was recognised, however, that there were other considerations which would have to be investigated before the results could be finalized.

Further tests were made by means of models on four types of bends as indicated in Fig. 7. Various ship speeds, varying from 5 to 10 knots with ahead and following currents from zero to 5 knots.

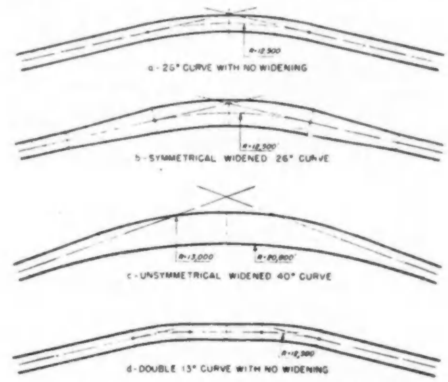


Fig. 7.—Curves Tested in Model Studies.

The first reaction of an observer is that a widened bend would provide more room for manœuvring than would a uniform width of channel in the bend. Actually, however, the widened bend studies indicated that manœuvring was more difficult, the actions of the vessels more erratic and the widths of ship paths were generally greater.

After careful observations of the behaviour of the model ships in the four types of bends, it was finally considered that the 26° parallel bend provided the best solution for all conditions of testing.

With a following current and sufficient way on the ship the vessel is actually in the bend a shorter time than with an ahead current, but naturally gives less time to the pilot for arriving at decisions and altering course. The tests showed that currents did not produce any hazardous operating conditions, the model could be navigated as readily in moving water as in still water.

Studies of the Suez and Cape Cod canals also confirmed that bends of uniform width were desirable. In the case of the Suez Canal, a parallel bend had been widened to provide room for larger vessels. Ships which previously had had no difficulty began to experience some erratic action. Therefore the bend was further widened in such a manner that it again became parallel.

It was agreed that a complete solution of the general problems of ship performance in restricted channels had not yet been obtained. The results, however, of the experiments and analyses thus far made, give a more complete understanding of a problem which had for a century harassed ship operators, engineers and pilots. It was accordingly felt that the conclusions arrived at would form a basis for the further studies which would be necessary when considering the design of channel.

5—Design of Channel

By J. E. REEVES and E. H. BOURQUARD, Assoc. Members A.S.C.E.

Although this Paper deals primarily with the design of the sea-level canal, there is no essential difference in the method used in the design of either a sea-level or a lock canal, except that tidal currents in the sea-level canal introduce a factor that must be considered. The maximum current of 4.5 knots arrived at in the studies described in the Paper on Tidal Currents was taken accordingly as the basis.

The design methods described in the Paper utilise the marine operating experience of existing waterways and the results of ship model tests conducted at the David Taylor Model Basin, some of which were described in the Paper on Ship Performance.

The forecasts of the maximum sizes of various classes of vessel to be catered for were examined together with the probable trends of design and density of traffic in both directions. The data already gained in the preceding studies and described in the various Papers was utilised in the design.

The channel depth was regarded as of prime importance in navigation and that within reasonable limits, the required width of channel is a function of the depth. Consequently, the depth was established prior to the determination of the channel width. Based on the experience of existing waterways and experimental work at the David Taylor Basin, a minimum depth of 60-ft. was considered adequate for the sea-level canal, and 55-ft. for a lock canal, having a shorter length of restricted channel, a lower transit speed and no currents.

The opinions of pilots and marine operating officials at the Cape Cod Canal, the Houston Ship Canal, the Suez Canal, and the existing Panama Canal were obtained, and the concensus of opinion was that a channel between 50 ft. and 60 ft. deep and 600 ft. wide would be ample for two-direction traffic of the largest commercial ships operating in currents up to 4.5 knots.

As a result of the studies and opinions obtained, it was concluded that the Panama Sea-level Canal should have a minimum channel depth of 60 ft. and a minimum channel width of 600 ft. at a depth of 40 ft., and that corresponding dimensions for an improved Panama Lock Canal should be 55 ft. and 500 ft.

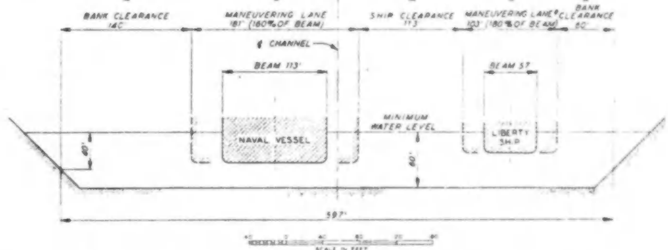


Fig. 8.—Elements of Channel Design: Sea-Level Canal.

Fig. 8 shows the proposed sea-level channel design.

The question of curves was carried further than the studies described in the Paper on Ship Performance and, although the maximum angle of 26° and a radius of 12,500 ft. and a parallel bend were regarded as probably satisfactory, it was recognised that further studies and investigation would be needed.

The present canal contains twenty-three angles with a total angularity of 598°, the largest of the angles is 67°, and four others are larger than 50°. The use of this alignment and a centre line radius of 12,500 ft. on the curves would result in almost 50% of the restricted channel of a sea-level canal being in curves, and was regarded consequently as unsatisfactory.

Investigation was made of possible alignments for a sea-level canal ranging from the present canal alignment to one absolutely straight from shore to shore.

The final proposed alignment is shown in Fig 3 (page 160 of previous issue), in which the maximum angle is 26° and the total angularity 117°.

While the channel dimensions, curves and alignment of the sea-level canal developed in this Paper were considered to be satisfactory, it was considered necessary that more information should be obtained and that further studies should consist of enquiries into the navigation of existing waterways and a con-

The Panama Canal—continued

tinuance of ship model tests conducted, using a larger scale than used previously to reduce the scale effects apparent in the former studies.

6—Excavation Slopes

By W. V. BINGER, Assoc. M.A.S.C.E., and T. H. THOMPSON, Affiliate A.S.C.E.

The geologic and soil mechanics studies conducted to establish stable slopes for the strata that would be excavated for a sea-level canal at Panama are described in this Paper.

Other matters exhaustively considered were the early and current geological investigations, the geological features of the area, the difficulties experienced with the slides that occurred during construction of the present canal, and the development of slope standards used in the preliminary design of the sea-level canal.

The geologic investigations of the canal region included mapping of all outcrops to be found along the line and natural exposures, such as stream channels, that had removed the deep soil overburden, and the sinking of core borings at selected locations to develop further the character, distribution and structural relationships of the underlying rock formations.

Aerial photography was also used to augment the mapping work.

A large proportion of the borings were made near the Continental Divide, where the sliding of two steep slopes in the original canal excavation indicated the need for careful study in setting the slopes required by the greater depths necessary for the sea-level canal. The deepest boring was 825 feet in depth.

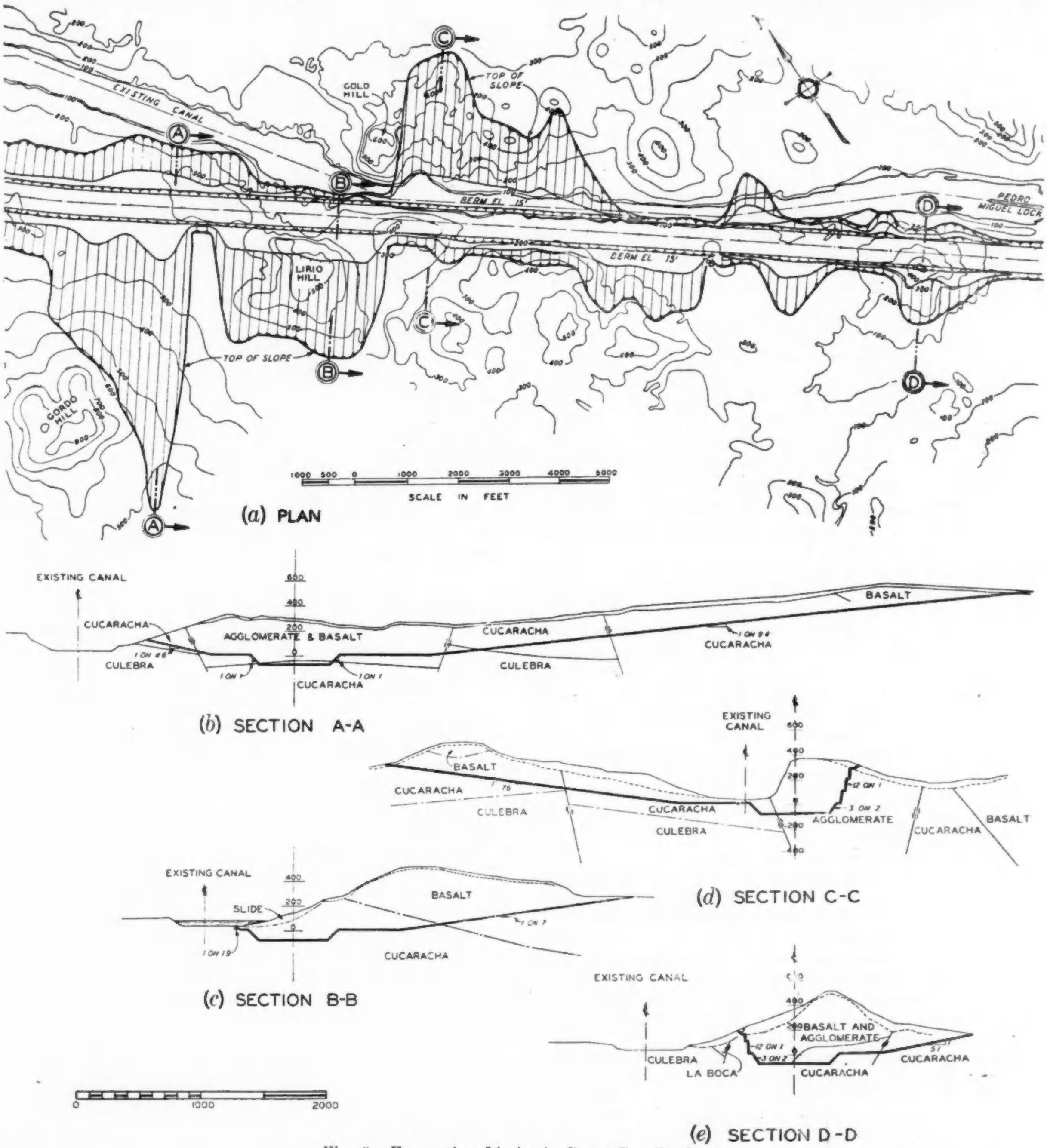


Fig. 9.—Excavation Limits in Deep Cut Section.

The Panama Canal—continued

Experience in the construction of the existing canal demonstrated that severe slides may result in cases where a deep cut is opened in a competent mass underlain by a weak material if the contact between the two materials is above the bottom of the cut or within limited distances below, and that this hazard can only be eliminated by a slope design involving a removal of at least a part, if not all, of the overlying hard rock mass above the line defining the stable slope of the weaker formation.

Slides in the Culebra Cut of the present canal have occurred from the very first commencement of the canal construction by the French, and have continued at intervals of a few years ever since, up to as late as 1931.

With the geologic formation changing so frequently, it was obvious that no attempt could be made to adopt a uniform slope for the excavation, but it was necessary that the channel cross-section should be as nearly uniform as possible, to provide the best navigation conditions.

No account was taken of the possible dynamic loads which might be imposed by the effect of large explosions of bombs. Neither were earthquake hazards allowed for in the design of the canal slopes, for the earthquake history of the region indicated that no serious danger exists of an earthquake large enough and near enough to place the canal zone within such a landslide hazard.

Fig. 9 shows the recommendations in respect to canal slopes of a four-mile section of the sea-level canal through the Continental Divide, north of Pedro Miguel. Approximately 30% of the total required excavation is concentrated in this area, and this section would also include the deepest cut.

Before actual construction would begin, more detailed geologic data will be available, and the slopes may be modified to take advantage of it. It is, however, believed that any modification would result in a reduction of excavation.

7—Strength of Soils under Dynamic Loads

By A. COSAGRARDE, M.A.S.C.E., and W. L. SHANNON, Assoc. M.A.S.C.E.

This Paper describes the apparatus developed and results of tests performed to investigate the strength characteristics of soils and soft rocks under dynamic loads, at Harvard University for the Panama Canal.

The investigations are being continued and are expected to also benefit other engineering problems, such as the effects of earthquakes on dams and their foundations, the effects of transient loading by fast moving traffic on airfield and highway pavements and the underlying materials.

Conventional strength tests on soils are either unconfined compression or triaxial compression or direct-shear tests. Loading of the specimen in such tests is performed over a period of at least several minutes.

It has been recognised that the strength of soil increases as the rate of loading increases. For example, in connection with the design of the third locks for the Panama Canal, a series of triaxial compression tests was conducted to determine the strength of undisturbed soft organic clay by producing failure within a range of from 1.7 minutes to more than seven hours. These tests indicated that the strength of the fastest rate of loading was about 4 % greater than that at the slowest rate.

The type of loading for the sudden or dynamic load tests was a transient load in which the test specimen was subjected to a rapid loading and unloading; simulating the effect of the first stress wave created by an explosion.

After a comprehensive review of dynamic testing apparatus developed for various purposes, the writers realised that none of this apparatus would be suited for the purpose now in view, and they were obliged to develop new apparatus of a somewhat different character for the application of the transient loading required for the new range of tests.

This apparatus of several types and the tests and technique of testing are described in the Paper, together with full data as to results.

The findings or conclusions presented in the Paper can be summarised as follows:—

(1) Strength of the clays and the Cucaracha shale loaded to failure in about 0.02 sec. was between 1.5 × 2.0 times greater than their 10-min. static strengths.

(2) Strength of sand increases only slightly with decreasing time of loading. The strength for the fastest time of loading (0.02 sec.) was about 10% greater than that for 10-min. static tests.

(3) Modulus of deformation of clay and Cucaracha shale for fast transient tests (time of loading about 0.02 sec.) was found to be approximately twice that for 10-min. static tests.

(4) Modulus of deformation of sand was found to be independent of the time of loading.

8—Construction Planning and Methods

By J. J. ROSE, F. L. DYE, M.A.S.C.E., W. B. WATSON and L. T. CROOK, Jun. A.S.C.E.

The principal construction features of the proposed Panama Sea-Level Canal are described in this Paper and involved investigation, studies and cost estimates of the most efficient and economic construction methods.

The principal features of the sea-level canal are a main channel 600 ft. wide at a 40 ft. depth, with a total depth below mean sea level varying uniformly from 60 ft. at the Atlantic entrance to 70 ft. at the Pacific end. The total length of the canal from deep water to deep water would be 46 miles.

The alignment would follow generally that of the present canal and would utilise the excavation accomplished for the Third Locks structures and the approach channels at Miraflores and Gatun.

The total required excavation would be 1,070,000,000 cubic yards, of which 750,000,000 cubic yards could be excavated in the dry. Dredging would be required for the removal of the remaining 320,000,000 cubic yards.

The maximum depth of cut to be excavated would be 650 feet, the length of canal at this depth being less than half-a-mile. Approximately 3½ miles of canal would be in cut deeper than 300 ft., 7 miles in cut between 200 and 300 ft., 9 miles in cut between 100 and 200 ft., and the remaining 26 miles in cut less than 100 ft.

The structural features are: (a) the tidal regulating structures, consisting of a tidal lock, a navigable pass and a gated water-control structure. The construction of these would involve only conventional methods. (b) The flood control structures, consisting principally of earth dykes and dams constructed mainly with excavation spoil. (c) Housing and facilities for construction workers.

Various programmes of construction were evaluated and it was determined that a 10-15 year construction programme, to convert the existing canal to sea-level, would be the most favourable.

Two main schemes of construction were examined: Conversion to sea-level canal by stage dredging and single stage conversion by deep dredging.

Two schemes for stage conversion were examined. In one study, seven stages of lowering the Gatun Lake were planned, and, in the other, three stages were selected. Either scheme would require progressive alteration of the existing locks, so that traffic could be accepted at all stages of water levels in the Lake.

These programmes would involve certain risks to shipping and to the canal if auxiliary conversion locks were not built, since only one lane of locks would be open to traffic at a time, while the other was being modified to accept traffic at the next lower stage.

A three-stage lowering conversion was considered the more practicable, involving the construction of special two-lane, single lift conversion locks at Miraflores and Gatun.

The Panama Canal—continued

The disadvantages of the stage conversion are:—

(a) The cost of the conversion locks required would add considerably to the cost of the project.

(b) All dry excavation would have to be carried out prior to the initial lowering of Gatun Lake and would require a minimum construction programme of 15 years to permit sufficient time for the two remaining stages of dredging.

(c) Traffic in the canal would be interrupted during the draw-down for each stage.

(d) Part of the material dredged during the second stage, and all the material dredged during the final stage, would require locking to sea for disposal, because the draw-down would prevent using Gatun Lake as a spoil area, and the use of the locks for this purpose would interfere with canal traffic.

(e) The lowering of Gatun Lake for the final stages would deplete the storage area to such an extent that pumping of lockage water would be required.

A proposal by E. E. Abbott for conversion by deep dredging led to the investigation of the possibilities of adapting or developing dredging equipment so that all wet excavation could be performed in advance of the lowering of the summit lake.

This investigation indicated that such a method would be entirely feasible, although drilling, blasting and excavating by dredging to depths of 145 feet below the surface of Gatun Lake would be required to provide the designed depth of the sea-level canal.

In this plan the present operating levels of the Gatun and Miraflores Lakes would be maintained during the entire period of excavation of the canal.

The level of Gatun Lake would be dropped a short time prior to final lowering to permit placing the flood control system of the canal in operation. The canal would then be closed for seven days, during which period the lakes would be lowered to sea level and the channel cleared of the barriers used to retain the Gatun and Miraflores Lakes during excavation.

The principal advantages of the deep dredging method of excavation over the stage dredging plan is in saving of lock conversion costs, and the saving of time—10 instead of 15 years.

Also the deep dredging plan permits full use of the Gatun Lake for deposit of all surplus excavation spoil, together with its use for hauling of excavated materials for the construction of the three flood-control dams, resulting in greater facility and less cost.

The dry excavation, it was found, could be accomplished by conventional methods and types of plant. Likewise the wet excavation down to more or less normal dredging depths could be carried out by conventional dredging plant, modified only as might be required for the special circumstances of the scheme.

It was only in the final stages of the excavation work where specially designed drilling and blasting craft and dredgers would be required for the working depths of 100 to 145 feet.

Conferences were held with various dredging contractors, dredger designers and builders, and the concensus of opinion was that such deep dredging was practicable. There was already in existence in the Californian Gold Fields a bucket dredger excavating to a depth of 124 feet, while 200 feet dredging depths had been predicted for the near future.

Three special types of dredging plant were therefore decided upon: Hydraulic and bucket ladder dredgers for depths of 85 feet to 145 feet, and dipper dredgers to be used for a maximum depth of 85 feet.

The hydraulic dredge spoil would be pumped to the nearest available disposal area, and for most of the material in the Gatun Lake a floating pipe line would be used, the pipe lengths varying from 3,000 to 12,000 feet, and, when in excess of 5,000 feet, shore powered booster pumps would be introduced in the line.

Under certain conditions, submerged pipe lines might be necessary to pump across the channel.

Preparation of rock for excavation under the deep dredging plan requires subaqueous drilling and blasting to depths far in excess of those ever before encountered in canal excavation. A deep drilling and blasting test was therefore conducted, in which rock was drilled, blasted and excavated in three lifts of approximately 25 feet each from 50 to 125 feet below water surface.

All drilling was performed by rotary drill mounted on a barge, and from the test the following conclusions were arrived at:—

(1) Drilling operations with a properly designed drill barge are not appreciably affected by the depths of water that would be encountered in the deep dredging plan.

(2) Dimensions of blasted rock obtained in all three lifts did not differ appreciably, the same unit explosive loading and hole spacing being used in each lift.

Port of Southampton Improvement Scheme

As we were going to press last month, the Southampton Harbour Board announced their approval of an important dredging scheme with the object of improving the approach channels of the port at an estimated cost of £700,000.

Some of the work will be carried out as a normal maintenance charge and will not require the raising of special funds, though much of the scheme can only be paid for through a loan.

The Board has therefore decided to promote a Bill in Parliament to obtain the necessary new borrowing powers and the authority to charge higher dues to shipping companies to cover the repayment and interest charges of the new work. The Bill is expected to pass through all its stages and receive Royal assent in July or August next year, but the Board will not consider increases in charges until the work has reached a more advanced stage.

The scheme, which is in four sections, embraces proposals which were originally formulated prior to the recent war and has now been revived at the request of the shipping companies, augmented by other suggestions made since the war for the general improvement of the sea approach channels and of those within the port itself.

The four sections are (1) straightening the western approach channel by the removal of 850,000 cub. yds. of spoil; (2) restoration of a portion of the Calshot channel to a depth of 38-ft., 150,000 cub. yds. to be dredged; (3) cutting off a portion of the bend in the channel at Calshot Spit by the removal of nearly 1,400,000 cub. yds. of material; (4) restoration to a depth of 35-ft. throughout, the main channel from Calshot to the docks, including the middle and lower swinging grounds, involving the removal of 1,000,000 cub. yds. of spoil.

The depth of dredging in the approaches and entrance to Southampton Water will be to a depth of 38-ft. at Low Water except the fourth section of the scheme as mentioned above.

The proposals are the result of a year's intensive work by committees and officers of the Harbour Board under the chairmanship of Alderman T. Lewis, M.P., and it is confidently expected that the outcome of the scheme will be the consolidation of Southampton's reputation as the world's principal passenger port.

It has since been announced by the Cunard White Star Company, Ltd., that, subject to the fulfilment of certain conditions, they are prepared to pay £75,000 towards the cost of the scheme. After stating that they are vitally interested in the dredging proposals, the company stipulated that their contribution will be made on condition the work of adjusting the Western Approaches and Calshot Spit is given priority and commenced at the earliest possible opportunity. The Harbour Board, at their last monthly meeting, decided that it might be more economical to carry out the whole of the dredging, capital and maintenance, under one contract, in which event the capital dredging in the Western Approach channel and at Calshot Spit would be given priority.

Argentine Free Port in Denmark.

According to a report received from Copenhagen, either Copenhagen or the Jutland Port of Esbjerg is likely to become the free port which Argentina is planning to establish in Denmark.

Coast Protection

A Survey of Beach Stability

By R. R. MINIKIN.

(Continued from page 169)

(6) Natural Physical Formation of the Beach Slope

Sand Beaches. On account of their low porosity and small grain size, sand beaches do not build up in the same way as shingle. Their most apparent characteristic is that they are very flat and even: there is, in nature, no definite indication of the formation of upper and lower beach profiles such as there is with shingle, particularly on a tidal strand. A very slight step is sometimes discerned on a lake beach where the water level is constant, and in shore pools of the Mediterranean. When a tide has receded from a sand foreshore, sand ripples, or corrugations, intersected by shallow flat drainage, channels and estuaries with unstable vertical banks are the only indications of water movement over the surface. The main reason for this difference in behaviour is the small grain size. Sand grains are not pushed along over the bottom like shingle, they are subjected to a widely different mechanical impetus.

On the passage of a wave over any point the loosely packed sand grains on the surface layer feel the impulse of the wave orbital motion and are accelerated forwards and backwards in the water immediately above the sea floor. Brigadier Bagnold in his model experiments found that under the accelerating forces the grains are projected in a spectacular loop-the-loop trajectory from one side of a ripple to the other, and back again. When these grains are in suspension, they are favourably disposed to be swept along by a current. These currents may be tidal or occasioned by wind. A wind blowing onshore, or offshore, will cause water currents as shown by the small arrows in Fig. 11 respectively. Thus it becomes apparent that an onshore wind may deplete a beach and an offshore wind build it up; which calls to mind the old fisherman's saying already quoted, but it does not follow that this is always the case, as there are other factors: the state of the tide, and the strength and incidence of the currents.

By means of special electrically controlled pressure recording instruments in use at the Oceanographical Stations in Great Britain and America, it has been confirmed that the variation of the hydrostatic pressure, at any point, due to the wave height above, or below, still water level, is transmitted to the sea bed immediately below. Over an extended period records have been made of the pressure variation, due to wave height of trains of waves, by this apparatus placed on the sea floor in 16 to 20 fathoms of water. It was definitely shown that the pressure, at any point, varies as the momentary hydrostatic head immediately above the point though the instrument only registers the average pressure in the area. It is therefore reasonable to deduce that a wave travelling in a given direction will tend to press the loosely packed grains on the sea floor in the same direction, similar to the action of a rolling pin on plastic dough. Owing to the rapid fluctuation of pressure, however, this action will be intermittent.

The reasons for ripple formation whether by wind, river current, or wave action, have not yet been satisfactorily explained; but

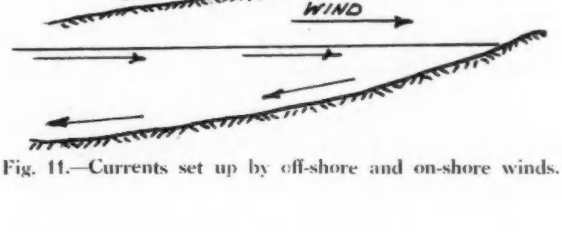


Fig. 11.—Currents set up by off-shore and on-shore winds.

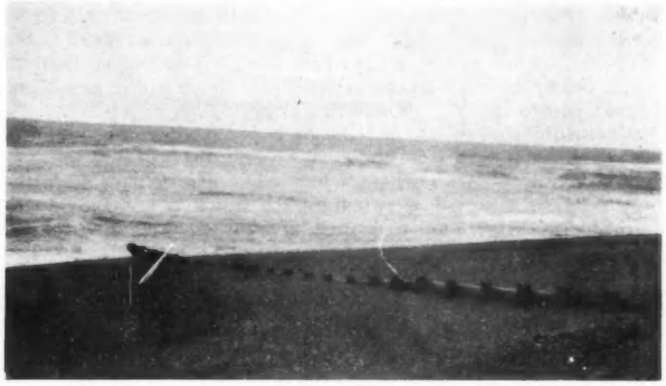


Fig. 12.—A groyne which shows 100% efficiency. It is, however, assisted in this by a shallow submerged reef of rock lying just below low water to the right of the groyne. This reef breaks up the waves before reaching the beach and reduces the violence. It also causes a deflection of the inshore tidal current to the lee of the groyne.

that does not prevent us noting that, even if the ripples remain more or less static, the sand grains composing them are in constant movement.

From observations made by the writer of a number of the sand beaches of the Belgian Coast and the N.E. Coast of England, he feels there is a strong case to be made out for wind action in the building up or denuding of a sand beach. In moderate dry and windy weather, after the tide has receded from the strand, the beach surface soon dries out and the sand grains are blown about in considerable quantities. At low tide on the sand flats skirting Rye Bay clouds of sand may be seen scurrying eastward under a S.W. wind, and on the N.E. Coast it is sometimes a painful experience to traverse the beaches in windy dry weather. It should be borne in mind that this visible movement at the speed of the wind only represents a small percentage of the actual movement close to the sand surface.

Submerged Bars. The formation of a submerged bank, or the existence of a shoal offshore, gives protection to a beach by the reduction of the open sea waves, even if there is a stretch of deeper water between the bank and the beach. The open sea wave in running over the slope of the bank will increase slightly in amplitude as the water becomes shallower. Provided the depth of water on the crest of the bank is greater than one-and-a-half times the original wave height, trough to crest, it will pass on into the deep water beyond with but a slight reduction. On the other hand, if the depth of water over the crest is less than 1.5 h, then the probability is that the wave will break and be projected forward into the deep water as a level surf. However, within a distance of one or two wave lengths it will again reform into a wave of 0.5 to 0.75 h, h being the original wave height. For example, waves of 4-ft. height will pass unbroken over a bank crest covered with water 6-ft. or more in depth, but in a lesser depth than 6-ft. they will break and reform into waves of about 2-ft. in height.

Generally, a shoaling lying off a coast line and just below low water tends to promote beach stability particularly those parts screened from the prevailing weather. Fig. 12 shows this quite well. The broken water to the right is traversing a rocky prominence on the sea bed. The efficient accumulation of shingle on both sides of the groyne is ample evidence of a local well being, but the groynes immediately to the weather side of the reef are not so healthy.

Coast Protection—*continued*

A very informative example of the vagaries of beach movement has been recently brought to the author's notice. A small embayment lying on the Severn Estuary has a shingle beach above the mud line, which lies between half tide level and H.W.O.N.T. The shingle is of large diameter and contains a high percentage of cobbles, or stone between 3-in. to 6-in. diameter. It lies in a bed some 30-in. thick over compact marl. The slope varies from 1 in 12 on the lower beach to 1 in 6 on the upper beach. The bay faces east and is protected on the north by jagged rocks down to half tide level. The rock stratum dips to the south at about 30° to the horizontal and passes under the marl. The physical effect is that of a wall to the north, everywhere about 5-ft. higher than the beach and following the beach slope. The fetch to the east is only 2 miles and to the N.E. about 12 miles.

When subjected to strong N.E. or N.N.E. winds the shingle on the beach is depleted from the area A (Fig. 13), close to the rock, and carried across to B where a low ledge of rock bars its further progress. In a period of two tides the beach is laid bare to the marl surface at A. On a change of wind to other quarters the shingle is gradually brought back again to the normal.

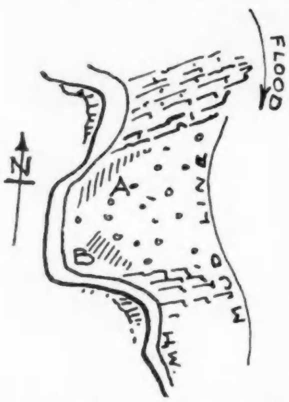


Fig. 13.—Movement of shingle on sheltered beach.

During heavy weather on a sandy beach the wave dissipation area becomes so turbulent that a considerable quantity of sand grains is continually in suspension. Even the foam becomes saturated with sand. If the sand grains are coarse there may be local building up, but for fine sands the tendency is to leave the beach depleted on a falling tide. When the waters above the plunge line are in this agitated state, the sheltered bays and the lee of obstructions, or prominences cause deposit. For example Fig. 14 shows a beach on the Belgian Coast. Long, low and wide stone-built groynes are shown by G. Off-shore there extends for many miles into the North Sea large areas of submerged mobile sand banks. The arrows show the direction of the flood tide current. It runs at about 3 knots. Under moderately heavy weather from the north there is frequently considerable accretion on the portions of the beach shown dotted; the upper beach profile in these areas attaining a slope of about 1 in 10 near high water line whereas elsewhere along the beach it does not exceed 1 in 15. On the other hand with a steady offshore, or southerly, wind there is an appreciable accretion along the whole beach.

Such problems of sand movement are only to be solved by full-scale observation. The conditions are too complex and delicate to faithfully reproduce in a model for tank work for they are

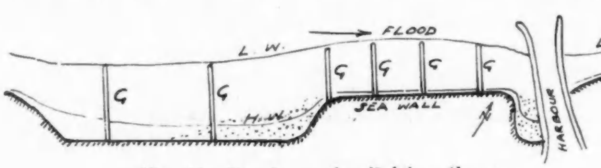


Fig. 14.—Beach on the Belgian Coast.

dependent on wind and water factors. This is tantamount to saying that each sandy beach should be considered on its merits after a close and thorough study of its particular regimen. However, we can, and do, learn in model work quite a lot about the tendencies due to a particular cause, and datae so acquired helps us to recognise and deal with similar symptoms on the full scale.

It will be gathered that a sandy beach is very unstable, and the point arises what factors go to the increase of stability.

Sand Traps. If some long impermeable island obstruction as A_1 B (Fig. 15) is placed across the path of the littoral drift stream in a uniform depth of water there will probably be some deposition in the lee and in the centre of the weather side. There will, at the same time, be scour on the bottom at the ends A_1 and B. If however the extremity A_1 is extended to A_2 in shallower water than B, the extent of the deposition will be increased in the lee of the shallower end for the beach building forces will be influenced to feed the narrowed inshore stream. Extending the shore end A_2 to A_3 into yet shallower water the greater part of the current will be forced round the end B. Then the probability is that there will be slight deposit on the weather side and considerable deposit on

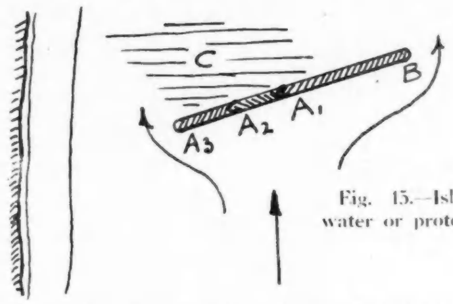


Fig. 15.—Island breakwater or protection mole.

the lee in the neighbourhood of C as shown by hatching. A full-scale use of this principle of sand deposition was tried out at Vizagapatam to trap the sand of the littoral drift. It should be emphasised that there was, in these works, no intention of beach building, or maintenance, and the example is only quoted to point the principle. The problem at Vizagapatam was to keep the harbour entrance clear of sand and to preserve a suitable depth of water for shipping. As the littoral drift was of the order of 1,000,000 tons per annum passing the harbour entrance it was decided that dredging was the most satisfactory solution. The difficulty was the heavy and almost ceaseless short swell to which the harbour was exposed to the S.W., making it hazardous for a dredger to operate for any length of time. The idea was to form a screen for the dredger, to the south of the harbour entrance, by what was, to all intents and purposes, an island breakwater. The construction was ingenious. The wall was about 1,000-ft. long and provided an excellent sand trap for the dredger working in the lee. It was estimated that only 3 per cent. of the littoral drift

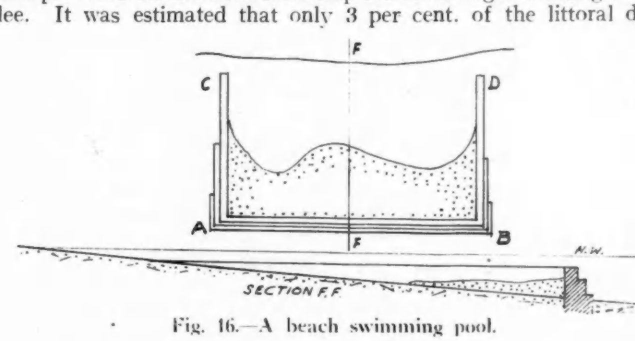


Fig. 16.—A beach swimming pool.

passed the outer extremity, the remaining 97 per cent. was trapped and dredged in the lee and shore end of the wall. The dredgings were pumped to the north of the harbour entrance to maintain the littoral drift beyond. It is worthy of remark that the wave reduction in the lee of the wall was less than half. By this means the harbour entrance was maintained at the required depth. Obviously had the dredger not been used the harbour would have silted up.

To take another practical case of accretion and one which, as the structure is built for a different purpose, is somewhat of an expensive nuisance. On some of the flat foreshores of the British Isles, paddling or swimming pools with low walls on three sides are situated near high water mark. The walls are submerged at high tides. In most cases these are found to silt up quickly in all weathers, the silting taking the form shown in Fig. 16. The contained water in the pool acts as a settling pond by reducing the turbulence of the waves flowing over it, and reducing the effect of the undertow, besides trapping the mechanically suspended sand

Coast Protection—continued

between the walls on the ebb. The same sort of thing occurs in small island paddling pools (Fig. 17), the deposit is not so great and takes the form shown in section. There is some scour at the ends and a scour trench at the outside of the seaward wall. The important point about these small examples is that the enclosed

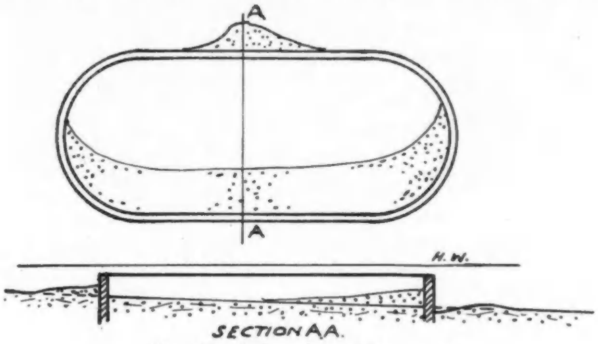


Fig. 17.—A beach paddling pool.

water space is a positive sand trap. On muddy estuaries they become mud traps.

Practical Examples

The major causes of the depletion of a beach are strong currents impinging for some time on a particular area, or a severe agitation set up by large quantities of broken water produced by wave energy dissipation, particularly so when the seas are travelling in the ebb tide direction of flow. These effects can be brought about in several ways; even by protection works designed to prevent them (Fig. 18).

Let us consider a few typical practical examples. Seventy years ago the Authorities of Bray, a township of County Wicklow, on the East Coast of Ireland, were alarmed at the heavy erosion taking place on the foreshore. This depletion of the sand and shingle took place spasmodically, first in one place and then in another on the three mile stretch of beach. There was a see-saw

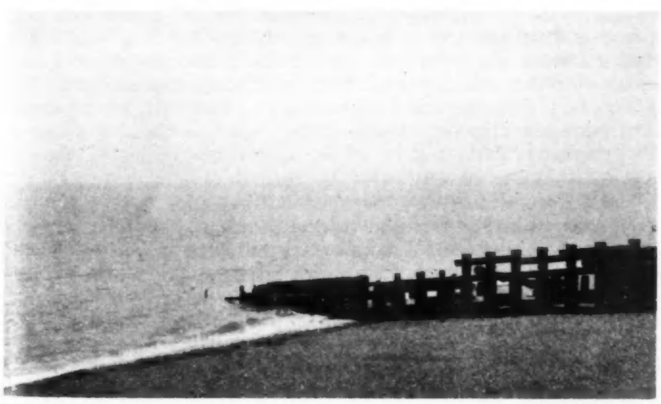
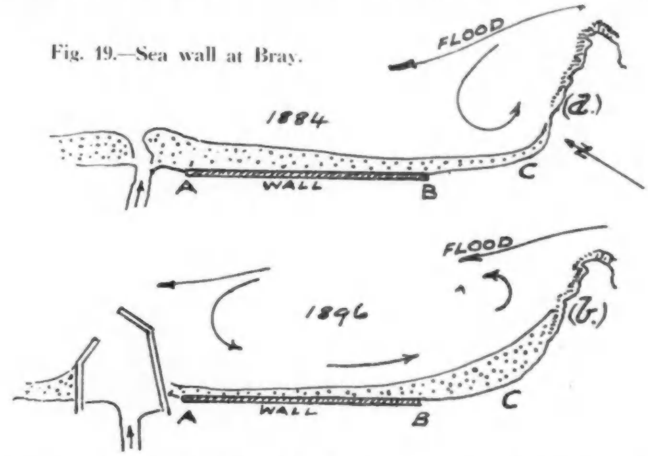


Fig. 18.—At the seaward tip of the groyne a solid concrete wall is panelled between timber king piles. Shorewards of this, the groyne is in bad repair for 50 feet. From the gap to the shingle crest the groyne rises from 6-ft. to 8-ft. in height above the beach.

action, a part already eroded would be partially rebuilt at the same time as another part was being depleted, which, as has already been seen, is not unnatural. There was one part of the beach, about one mile south of the town centre, which was heavily denuded and showed no sign of recovery. This point (marked C (Fig. 19) lay in the elbow or root of Bray head which extends seawards from the general coast line for about half-a-mile. There was no immediate danger to the more valuable property of the town, but the fickle nature of the beach regimen forced the authorities to take preventive measures. To the north of the River Dargle, the Railway Company built stretches of sea walls and groyned the beach to protect the track which skirts the foreshore. To the south, it was decided to build a sea wall of about 3,400-ft. long from A to B (Fig. 19a). The littoral drift on the Wicklow Coast is south to north, following the direction of the flood tide. The wall as then built in 1884-6, had a substantial

Fig. 19.—Sea wall at Bray.


cross section, hatched portion, Fig. 20, and contemporary records say that it was founded for the greater part on a bed of stiff boulder clay covered by 11-ft. of shingle at the high water line, which was the approximate line of the wall.

Within four to five years of the completion of the sea wall, the breakwaters of Bray Harbour were constructed (Fig. 19 (b)). From the date of the completion of the south pier, which extends seaward for some 600-ft., a change took place in the beach phenomena. It was noted that local along-shore drift of the mobile material was now definitely north to south. Accretion was taking place to the north of the North Pier and on the beach at C to the north of Bray Head. Heavy depletion to the south of south pier and along the northern section of the sea wall exposed the latter to within a foot or two of its base. The authorities in 1914 took remedial measures to preserve the wall from destruction. A masonry apron with timber walings at the toe were constructed to the front of the wall (Fig. 20). It will be noted that the top of the apron is about 4-ft. below high water and the base almost at the denuded beach level, leaving only 3-ft. thickness of shingle

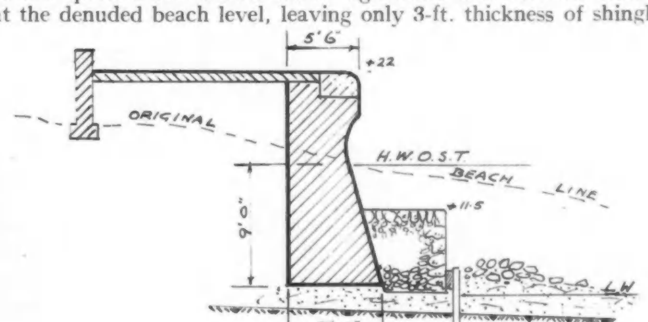


Fig. 20.—Cross section of Bray sea-wall, showing protective apron at toe of original wall.

resting on the cliff clay. A quantity of large rubble was tipped on the beach in front of the apron. Thus for a time the stability of the wall was assured.

Eventually in 1941 the structural condition of the wall became serious. For a large part of its length the apron was demolished and the base of the wall completely exposed by an almost complete depletion of the shingle. Even in this condition the sturdy character of the wall maintained it in its vertical position.

While remedial measures were being considered a succession of easterly gales attacked the coast and demolished 100-ft. of the wall and roadway, and seriously threatened the major portion of the

Coast Protection—*continued*

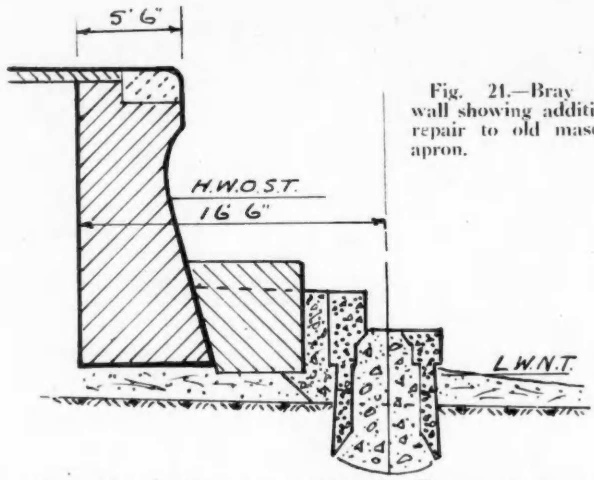


Fig. 21.—Bray sea-wall showing additional repair to old masonry apron.

wall, where the footings were exposed. Temporary measures were hastily put in hand to limit the damage. Such is the history before the main works of repair were undertaken. Let us then compare the actual conditions with what we have already defined as the essentials of natural beach stability.

When in 1884 the sea wall was first constructed there was an ample beach of sand and shingle of which the natural high-water contour followed the present line of the wall. The beach crest at this time, judging from the original profile (shown dotted, Fig. 20), was 10 to 20-ft. landward of the wall face. Hence the preliminary location of the wall at the high water line was the first infringement of the conditions of natural stability. It will be appreciated that the almost impermeable barrier represented by the wall would promote the tendency to scour a trench in the beach at the wall. The wall, however, was founded on about 2-ft. of shingle overlying the impermeable clay, and not in the clay, and was also provided with 9-in. diameter drains. The combined effect of these two filtration channels would be to cause a see-saw quicksand action, first in the back fill under the head of the surge crest, and second in the beach, to the front of the wall, on the seaward return of the surge. The result would be a drawing down of the backfill, which was shingle and sand, and a flattening of the beach slope. The material so disturbed would be drawn seaward and then pushed along to more comfortably conditions areas which, in this case, was the natural undisturbed beach to the south of the wall.

would have been more effective had it been located behind the then beach crest, that is some 20-ft. landward of its present line. If these conclusions are correct then the wall itself initiated the beach depletion, which extended to some inches of the footing base. The first remedial measures were not so well adapted as they might have been had all factors been taken into consideration. It would appear that the concern was confined to the prevention of the washing-out of the toe rather than to the causal forces of the beach instability. A masonry apron was constructed at the toe of the wall with footing level about 6-in. only below the wall footing. There was now no less than 9-ft. of water at H.W.O.S.T. at the wall, and at low water but only a few feet of dry beach, so that the wall was actually subjected to buffeting by the sea for most of the 24 hours daily. The addition of rubble in front of the apron was also a dangerous procedure for it was providing the wave action with ammunition, which it eventually used with telling effect. All the apron did for a time was to slightly decrease the hydraulic gradient of the seepage water below the foundations and to prevent the wall being undermined.

Whilst this depletion was becoming serious in the lee of the harbour breakwater at the northern end of the wall, the south shore was being heavily accreted, in fact, near the south end of the wall it buried the coping. Obviously this points to disequilibrium in the porosity of the beach at the northern sector of the bay and the drift of material to the south. The remedy would have been to trap the material by groyning.

In 1941 it was decided to undertake repairs to preserve the sea wall. Handicapped at this time by the short supply of structural material, due to the war, the engineers, prominent among whom was Mr. H. A. Delap, decided that it would be more profitable to repair and strengthen the toe of the sea wall rather than to attempt any reclamation of the beach. To this end a dwarf concrete wall forming a further seaward step, was constructed in front of the original apron (Fig. 21).

The base of this wall was founded about 3-ft. into the boulder clay effectively sealing the backfill from sea filtration. The 9-in. drains in the original wall were plugged. In view of the fact that there was little porous beach left, the resultant effect on beach stability of this further forward placing of an impermeable bulkhead is negligible, as sooner or later if the works are still unprovided with groynes or palisades the depletion will lay bare the clay layer. The design of the wall was ingenious. Small pre-cast concrete rectangular caissons 11-ft. by 5-ft. by 5-ft. deep, in two sections of 2-ft. 6-in. deep were let into the clay. The walls of these units were 9-in. maximum thickness at the base and ends, tapering to 6-in. thickness at the top of second unit thus forming an internal working chamber of 4-ft. wide by 9-ft. 6-in. long. The bottom unit was provided with a bevelled cutting edge to the outside. They were placed in position on the beach and the clay scooped out, mostly by manual labour. At grade they were filled with mass concrete and sturdy cap-pieces fitted on the top keyed into the core concrete. The original apron, where in good condition.

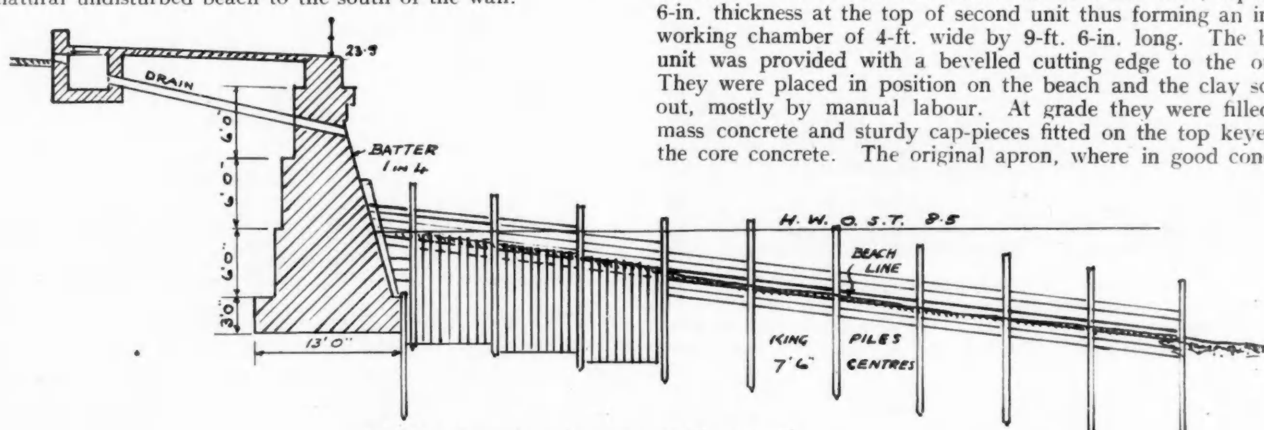


Fig. 22.—Sea wall and groynes at Aberystwyth.

When the wall was first designed if the intention was to treat it as a property protection wall only, then it should have been founded at least 3-ft. deep into the boulder clay, and provided with internal counterforts at intervals. On the other hand, if it was intended to combine a promenade wall with beach amenities for holiday makers a low system of groynes and palisades should have been comprised in the scheme. Again, the wall for both cases

was combined with the new wall by filling in solid with concrete. In other places it was replaced by mass concrete (Fig. 21).

There is little doubt that the professional skill in the design and construction of this latest repair is of high order, but in the author's opinion it is still inadequate to ensure long-term stability. It is known that with heavy weather from the south there is a considerable temporary accretion on the north shore, sometimes

Coast Protection—continued

as much as 6-ft. depth in one gale. Obviously this should be trapped before it is swept away.

It is profitable to compare the above example with a new wall built at Aberystwyth just before the late war. This wall of plain concrete with hard stone facing replaced an old masonry wall completely destroyed by a violent storm in the winter of 1937. There is a shingle foreshore with a general slope of 1 in 8, or 6° with the horizontal. The face of the old wall was vertical with old-fashioned semi-circular bastions at about 400-ft. centres. Winds from the N.W. sector are most severe. For the reconstruction it was decided to batter the face of the new wall and add a stepped over sailing coping (Fig. 22). The line of the old wall was slightly landward of H.W.O.S.T. line so that in calm weather there was always a strip of dry beach. The new design to gain an increased width of roadway and promenade located the face line of the new works some 15 to 20-ft. seaward of the original line. This meant that at High Water Springs there was 12 to 18-in. of water at the wall, in other words the beach was submerged. This is not a favourable feature and to mitigate any ill-consequences from this beach encroachment timber groynes 70-ft. long at 150-ft. centres were constructed and steel sheet piling driven 15-ft. into the beach, to rock, at the toe of the footing, to which the heads of the subsequently burnt-off sheeting were bolted.

To appreciate the disrupting forces, due to wave action, that a wall of this type, located at about high water mark, has to withstand during heavy weather we cannot do better than consider two incidents on this new work. For the construction of the new wall a heavy timber temporary gantry was erected over the whole site and Larssen 10a sheet piling driven on the sea face to form a cofferdam. This sheeting was braced by heavy scantling timber struts and was also tied back to anchor piles by stout steel chains.

In addition, transverse sheeting bulkheads were driven at 50-ft. centres behind the outer cofferdam sheeting dividing up the site into compartments. As a further safety precaution the back of the outer sheeting was supported by tipping quarry waste as a temporary bench fill.

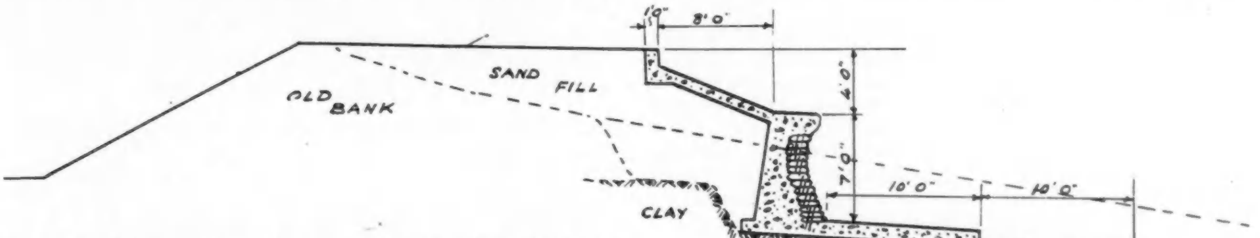
In one section the construction of the wall had reached a height of a few feet above the footings when a severe storm occurred. In spite of the top edge of the cofferdam sheeting being at a height of 13-ft. above high water springs work had to be suspended as large quantities of water and shingle were projected into the working compartment. At the height of the storm the green water was thrown high into the air and in its fall between the wall and the sheeting exerted so high a shock pressure that the latter was burst outwards, the steel chain ties were snapped and several sheets were sheared off at beach level.

The other relevant incident of note happened after the completion of the groynes. A heavy wave stroke sheared the three $1\frac{1}{8}$-in. diameter bolts securing the wall plate of 10 by 10-in. timber connecting the groyne to the wall.

The important point about these occurrences is the hazardous effect of locating the face of a sea wall of this type near to, or seaward of, the High Water Springs line. If such strongly-built connections of tough material give way under the disrupting forces of an opposed wave surge how much more vulnerable will be a loose shingle beach limited in its capacity of absorbing the energy naturally by reason of the location of the wall.

One of the most difficult stretches of coast line in the British Isles is the north-east bend of Norfolk. Here the littoral drift is north to south, whereas where the coast bends westwards towards the Wash, the drift is east to west. In this part of the country the land is very flat and a large area would be inundated at High Water Springs were it not protected by earthen banks. The foreshore is flat and the horizontal tidal range is considerable though the vertical range at ordinary springs is only 6.25-ft.. Almost annually breaches occur in the earth embankments fringing the coast line. The tops of these banks are about 15 to 16-ft. above H.W.O.S.T.

The occasional storm surges frequently raise the water level several feet above the normal, in some parts reaching 9-ft. above H.W.O.S.T. threatening the countryside with disastrous floods. These storm surges which enter the North Sea round the Coast of Scotland are due to fluctuations of barometric pressure. They may reach the Norfolk Coast in 12 hours after passing the Orkneys.



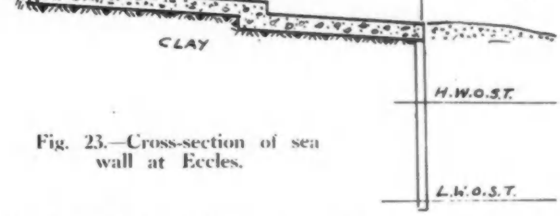


Fig. 23.—Cross-section of sea wall at Eccles.

If the time of arrival coincides with, or is near to, high water then the resulting level of the tide may be several feet above the normal. There is, of course, a reverse effect but that is not relevant to our purpose. Even if the time of arrival is about half tide a 4-ft. high travelling surge would produce an abnormal rise.

Apart from the meteorological surge abnormal tides may arise from the wind. The wind effect is always greater where the depth of water is least, and on wide stretches of shallow water, such as is encountered on this coast; a northerly gale during high water may increase the level of the seas considerably. This most easterly shoulder of England is fully exposed to the north without any protecting headlands. In calm weather there is generally a wide strip of dry beach between the toes of the banks and high water springs line. In some sections the old banks are entirely of sand fill covered with Marram grass, and some sections have a sub-foundation of clay.

Owing to the low-lying nature of the land behind the banks natural drainage is difficult, and even when assisted by careful siting, and scrupulous clearing of ditches, it is extremely slow. This causes in places a seepage through the bases of, or under, the banks, with the result that a quicksand effect is created. This is more pronounced in winter when the ground is saturated, and when there is the greater likelihood of northerly gales.

Thus when breaches almost half-a-mile long occurred in the banks during the February, 1938 gale, the difficulties of the problems confronting the engineer, Mr. S. W. Mobbs, can be imagined. A large area of land was flooded and temporary repairs to the banks became a paramount necessity. Since, as always, with this class of work the strictest economy is exacted, the choice of repair schemes was limited. Nevertheless several ingenious methods of construction were adopted. There were two different designs of new wall constructed for places within 4 miles of each other.

At Eccles, where there is a higher level of beach at the site of the wall, the cross-section, as in Fig. 23, was decided on. At Horsey, where the high water line was nearer to the wall the cross-section took the form shown in Fig. 24. The portion of the latter hatched horizontally with dash lines shows the extent of the temporary bank to stem the breach. This was built of sand-filled

Coast Protection—continued

bags with a facing of concrete-filled bags, and later was incorporated in the permanent reconstruction. It was decided for economy of labour and materials and rapidity of progress that concrete-filled bag construction should be used for the facing throughout. After placing, these bags were secured together by skewering them while still green, with ½-in. diameter steel rods 18-in. long. The summit wall was eventually backed by concrete carried over the top layer

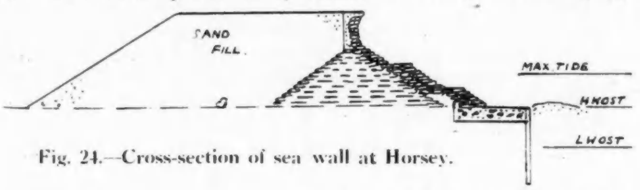


Fig. 24.—Cross-section of sea wall at Horsey.

of bags to form a coping. A substantial sand back fill, later planted with Marram grass, was tipped in the rear of the wall. The front face had a slope of 1 in 1½ with two 18-in. wide berms. The toe of the wall abutted on a concrete mattress 12-ft. wide and 2-ft. thick, the top of the slab being about high water level. Steel sheet piles, Larssen 10a, 13-ft. long were driven at the front edge of the slab and secured to it at the heads by 1⅛-in. diameter tie rods cast in with the slab. At the points where the groyne extremities joined the slab, concrete abutments about 4-ft. high were cast in with it.

At Eccles a vertical wall with a reinforced concrete backing and bag facing was founded on a reinforced concrete mattress 25-ft. wide sloping seaward at 1 in 20 with a central 12-in. step. The sheet piling at the toe was similar to that at Horsey.

The engineers held the opinion that it is more profitable on this coast to delay the drift of the sand along the beach than to attempt measures of deposition. This they do by low groynes; which are from 400 to 500-ft. apart and about 300-ft. long. They are of sturdy construction, driven about 10-ft. into the beach, and aligned at an angle of 10° away from the normal to the direction of the littoral drift.

Though these walls are generally sited an appreciable distance landward of the normal surge crest line or high water, there will be the tendency to scour a trough just in front of the toe, when the water level during abnormal tides submerges the toe slab.

This is to be noticed on a similar type of sloping sea wall much used on the Belgian Coast (Fig. 25 (a)). Where the tide reaches

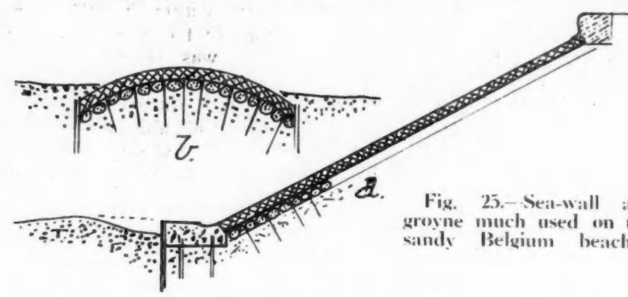


Fig. 25.—Sea-wall and groyne much used on the sandy Belgium beaches.

the wall the surge rushes up the pitched brick slope and, as will be appreciated, returns from its rest position with energy little less than the original amount. This scours out the sand at the toe, which is protected by timber sheeting. Although on the whole, the high sloping walls, or digues, on this coast have proved serviceable over decades they are not a suitable form to preserve beach amenities in less favoured spots. This coast has the advantage of an illimitable supply of sand from the banks lying offshore, and the beaches are wide and flat. The winter storms favour accretion along the coast and sometimes the beaches are built up some 6 to 8-ft. in depth alongside the more sheltered walls. As shown in Fig. 25 (a) the facing of the wall is in coursed brick laid on brushwood fascines staked to the bank. The construction of the hump-backed groynes (b) is similar. These groynes are more suitable for maintenance of a beach level than for promoting accretion of sand.

(To be continued)

The Economics of Cargo Handling

Problems of Mechanisation and Labour

By GEO. B. LISSENDEN, M.Inst.T.

In November last, when a team of American business efficiency experts were in this country examining our industrial set-up, the dockers employed at one of the London wharves struck rather than use a certain type of stacking machine which, the men claimed, would put a number of them out of work.

On the 6th November, a leading Daily Newspaper published a series of photographs of the machine which caused the dispute, and said of it: "This machine poses the problem: Will workers in Britain use mechanical aids to increase their powers of production and the wealth of the nation or will they, like the odd Luddites, attack the machines as the enemy of their prosperity? This machine is not unique. It is one of six types made in Britain, and others like it are extensively used in the U.S.A. It can do the work of 12 men; properly used, it would halve the time taken to unload ships and greatly reduce the costs."

Certain types of mechanical appliances can be put to good use in dock work, but there is no justification for the statement that one of them will **halve** the time normally taken to effect the discharge of a vessel containing general cargo. With bulk cargoes —of iron ore, grain, etc.—grabs, elevators, and so on, will admittedly speed up the work considerably. But there is a limit to what can be done in the holds of a ship, or on the quay, by mechanisation.

And in any event, the introduction of machinery merely means, often enough, that the cost of handling the goods is transferred from one location to another—or, to put it more plainly, from the shipowner to the receiver of the cargo—and in many cases **actually increased,** when the "fixed charges" and what-not are taken into account.

What American Stevedores Have to Say

It may be well to consider what has been the experience in America, where machinery has been introduced extensively. At the annual meeting of the American Association of Port Authorities, held in New York in October, 1944, Captain Blanchard, one of the leading stevedores in the U.S.A., said this: "To look at the waterfront problem right, we have to review it a little. In this town of ours here we have all or many of the ailments of all the ports in the world. Let us look back just a few years—say fifty—and see how we have improved here.

"Fifty years ago the majority of piers in this port were simply uncovered piers, probably few of them more than 500 feet long, and most of the cotton was hoisted into the vessels by one horse-power—just a plain, every-day horse. It was all loaded into the one hatch in the middle of the ship, and most of the vessels were of the old wind type.

"Then came the steamer, and we had to cover the piers. Cargo had to be assembled ahead of time, or it had to be discharged from the vessels with speed. The old sailing vessel was loaded with the cargo the same day it was ordered down to the pier.

"But when the steamer came, and it was 'Hurry! Hurry up!' instead of one gang and the horse we had steam winches and many gangs. Cargo had to be thrown out with speed, piled on the pier, and the inward and outward had to be assembled prior to the arrival of the ship.

"Then, of course, we had the longshoreman—with a strong back and feeble mind—with the hand truck. We worked them ten hours a day, and more sometimes. The production at that time was about one ton per man per hour. I am telling you that

The Economics of Cargo Handling—continued

because I want to show you that, with all the 'isms' and improvements that we have, we haven't increased that one ton per man per hour.

"The hand truck was a happy tool for many years, but the units which were being put into the ship ran about 1,500 pounds. We had to increase that. Labour was increased, and the units were increased to about two tons. That was due partly to the increased capacity of the ship's gear.

"Then we brought in the travelling crane; the first one was a Ford tractor with a lot of mechanism attached to it, a horrible looking thing, but it seemed to do the work. Since then we have brought in the lift truck, which picks up the draft and takes it to the hatch.

"At first labour was a little antagonistic against this equipment. In fact, in many cases, when the foreman wasn't looking, they used to drive it overboard. They jumped off in time to keep from going overboard themselves. But now there has been a change and they almost refuse to work unless we have that equipment.

"But the number of men in the gangs, in spite of this equipment, has had to be increased, and the production per man per hour hasn't varied in the last forty years. It is about one ton per man per hour. That is a rather strang thing, when you stop to think that we have put on to the pier many, many thousands of dollars' worth of these patent toys.

"One gang years ago was about eleven men, and the equipment cost about a hundred dollars—a few trucks, and so on. The cost to-day, with a gang of twenty-two men, of the equipment is about five thousand dollars a gang. Still, with all that, we haven't increased our production over what we had in the olden days."

A Personal Experience

Several years ago the present writer was persuaded to introduce a dozen petrol-driven trucks for the purpose of receiving slings of bagged cargo from the ship's falls, and transporting these slings from the quay into the transit sheds for storage—it being argued, in support of the changeover, that this would be a quicker and cheaper process, and enable the ship to be discharged in far less time. But what, in fact, happened?

Admittedly, no truckers were required, and to that extent there was some saving. But although the rate of discharge from the ship was very little increased, several more men had to be employed at the pile in the shed where the stacking was done—because the men already there protested that they could not keep pace with the job unless they were given some help, and on balance there was very little saving in labour costs.

But—and this is the second and bigger "but"—although each and every man was put to a thorough test before he was allowed to act as a driver, the trucks got knocked about badly and therefore required constant overhaul. That meant—besides a proper storage place for the trucks when not in use, e.g., at night-time and week-ends—the provision of a repair shop and the services of a mechanic, who, incidentally, insisted on having an assistant in accordance with the rules of his union.

The loss of petrol through syphoning became, in time, a positive scandal. Unless the trucks were put under lock and key when not in use, the petrol tanks were invariably emptied—by whom it was impossible to discover, unless watchmen were appointed to keep a constant eye on the plant.

It was, therefore, very soon found, to be quite frank about it, that whereas on the face of things there had been a step in the right direction—in that machinery had been introduced to do the work of men, and do it quicker—**the total all-in cost was greater.** Labour costs were down a peg or two, but the "overheads" were up considerably.

True it is that this experiment was made at a time when labour was not at its best and brightest—when, to put it in other words, the men weren't exactly amenable to reason—but such has usually been the present writer's experience. Any number of similar examples could be given, but the foregoing will suffice for the moment.

We Must Mechanise, Nevertheless

Now, having said that, the writer, as an old hand at the game, hastens to add that he appreciates, and to the full, that we simply must mechanise our industries, all of them, if we Britishers are to get back on to our feet again and then hold our own in the markets of the world. But he is equally convinced that we are, or many of us are, tackling the problem from the wrong angle and assuming that the so-called work people—or a good many of them—have a "Luddite" mentality. They **certainly have not,** and the sooner we get rid of that old-fashioned notion the sooner we shall recover our lost position as a leading nation.

The matter was put quite plainly by Mr. A. Curle at the meeting of the British Association held at Brighton in September last. He said: "The only solution was to remodel society, to substitute for an unconscious response individual responsibility, based on a real appreciation of the group's needs and to reforge the link between work and the rest of life. Social science techniques must be used to inculcate this feeling of participation." If we continue to tell ourselves, as some do, that that sort of philosophy is "too remote" from our pressing needs, we are only making bad matters worse.

Lecturing at the hundred and ninth annual meeting of the Union of Lancashire and Cheshire Institutes in October, Sir George Schuster put it this way: "I want to see industrial production interpreted not as a low-grade, selfish scramble for profit based on sharp practice, but as an activity of supreme national importance which gives scope for qualities of intellectual ability, leadership, human understanding, integrity and côurage, and calls for an ideal of 'excellence' quite as honourable as excellence in culture or art or other forms of human activity."

Speaking Generally

What is required to-day is not a further concentration of the "job analysis" business, of which we have heard so much lately, but an appreciation of what the human being really means in the general scheme of things. Men are resentful and ready to down tools if someone stands by, with a furrowed brow and stop watch in hand, doing the time-and-motion-study stuff, because—make no mistake about this—they realise the injustice of starting at **their** end of the social scale instead of at the top of it.

But men, and women too, of course, can be educated—or, if the word is preferred, trained—to do anything, use any type of machine, if there is the correct approach, provided, that is to say, the workers are persuaded that it is a matter for intelligent co-operation, and that they too will gain by the innovation. In many cases a much greater output can be effected by the co-operative, all-out effort, and that is the end at which we must aim.

Coastal Shipping Advisory Committee.

A preliminary meeting of the Coastal Shipping Advisory Committee, set up under the Transport Act by the Minister of Transport, the Rt. Hon. Alfred Barnes, M.P., was held at the Ministry of Transport on the 17th November last.

The Minister, who attended at the opening of the meeting, welcomed those who had been appointed members of the Committee and thanked them for undertaking the important work which had been assigned to the Committee, stressing the real importance in the national interest of ensuring a proper co-ordination of inland transport and coastal shipping.

The Committee has elected Lord Rusholme to be Chairman and Sir John Fisher to be Deputy Chairman. The British Transport Commission and the Chamber of Shipping are being asked by the Committee to provide Joint Secretaries.

In accordance with the provisions of the Transport Act this Committee is to consider and from time to time report to the Minister on all matters which may jointly affect the interests of the Commission and those of persons engaged in coastal shipping or which the Minister may refer to them for consideration. The Act leaves the Committee free to appoint its own chairman and determine its own procedure.

Radar for Gravesend-Tilbury Ferry Service

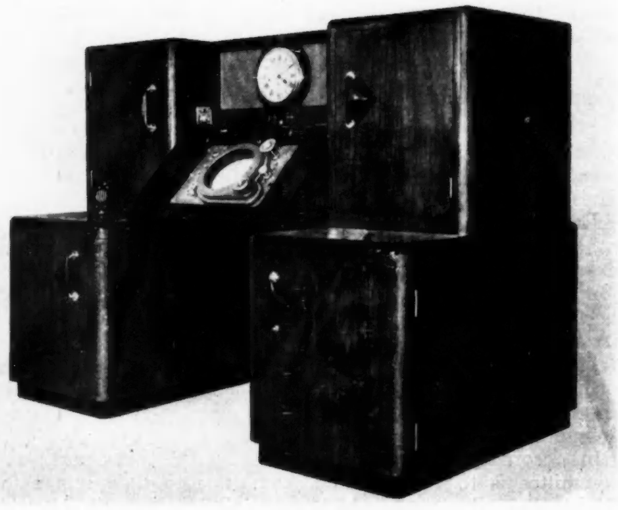
Description of New Shore-Based Installation

Every year more than three million passengers and many thousands of vehicles are carried across the River Thames on the ferry service between Gravesend and Tilbury. These impressive figures would be greater but for the fact that the service is sometimes completely interrupted by fog. Many of the regular passengers on this route are workers in the docks at Tilbury, and

Ferry approaching Tilbury Landing Stage.

in consequence delay to them means a hold-up in the loading and unloading of perishable and other cargoes. To minimise these delays and to overcome the serious consequences which may be entailed thereby, British Railways recently decided to use shore-based radar.

The decision to use the shore-based type of installation resulted from a close study of the very successful equipment of a similar character installed for the Wallasey Corporation Ferries by Messrs. Cossor Radar, Ltd., a description of which appeared in the October, 1947, issue of this Journal.



View of Indicator Console.

Satisfactory use of this type of equipment in operation depends to a considerable degree on the close co-operation between the operator at the set and the Master on the ferry. During periods of low visibility, the operator, by virtue of the radar screen, has continually before him a clear picture of the river. It is, therefore, his duty to maintain the closest contact with the ferry captain, advising him constantly by radio not only of the correct position of his ferry but also of the movements and whereabouts of other vessels in the river. By an intelligent study of the radar screen, an operator can tell not only the size of any vessels in the vicinity, but can plot their course, compute their speed, and calculate the bearing of one vessel in relation to another. His knowledge, with experience, can in fact be so invaluable that he is able, when occasion demands, to advise the Master from the moment of casting off until the ferry is in a position to manœuvre alongside the opposite landing stage.

Siting the Equipment

The Indicator unit at Tilbury has ranges of .8, 1.2 and 3 nautical miles. With these scales the operator may observe the ferries themselves at close range or, alternatively, he may see them in relation to other vessels in the river some miles away. Thus, if during foggy weather a radar equipped ship is approaching the crossing place, the operator is able to warn the ferry captain in ample time.

Scanner Unit mounted on Clock Tower.

As the accompanying illustration shows, the Indicator mechanism is enclosed in an impressive console of functional design. This console, in polished walnut, comprises a special fitting supporting the Indicator screen at an angle which permits the P.P.I. picture to be studied from a comfortable sitting position. Immediately over the Indicator are switches for the Marconi simplex transmission equipment, together with remote controls for the normal room lighting, whilst the panel above frames an 8-inch diameter marine timepiece, flanked by dual matched speakers. Cupboards on either side of the centre unit contain the ancillary electrical equipment, and a small wooden desk holder is provided for the R/T microphone hand set, the cable for this being concealed when not in use.

The Indicator console is accommodated in a room which has been specially provided at ground level immediately adjoining the booking hall at Tilbury Station. In the centre of this hall is a

Radar for Gravesend-Tilbury Ferry Service

—continued

booking and luggage office, on top of which has been placed the Alternator, Rectifier and other electrical equipment. In the clock tower over the station roof, the Main Rack is housed, and above this again, topping an 18-foot tubular mast, is the Scanner unit.

Many points had to be borne in mind before the most suitable site for the Scanner was found, but here, 80 feet above ground level and at a horizontal distance of some 120 yds. from the ferry arrival platform, it is in a position which enables it to satisfy all requirements.

Technicalities

Transmission to the Scanner is by a 30 foot run of standard waveguide. The aerial beam width is $\pm 1°$ on the horizontal beam and $\pm 15°$ on the vertical beam, and the speed of rotation is approximately 32 revolutions per minute. The Transmitter equipment works on a frequency band between 9,425 and 9,525 Mc/s per second, output power 30kW., pulse width .2 microseconds, repetition 2,000 pulses per second. The band width of the Receiver is ± 4 Mc/s per second at 3 decibels. The Indicator utilises a special 9-in. cathode ray tube operating at a voltage of 8 kV. The screen material is a special fluoride composition having long "after-glow" and almost total absence of primary flash. Separation is made between two objects differing in bearing by more than 2°, or in range by more than 40 yds. The cable run between the Main Rack and the Indicator is 75 feet. The entire equipment operates from 180 volts 500 cycles obtained from a 110 D.C. supply, by means of a rotary convertor. This convertor is fed from a 3-phase A.C. supply via a mercury pool rectifier. The power consumption is 2.5 kW., plus an additional kW, for Scanner heaters when the atmospheric temperature drops below 0° centigrade.

The juxtaposition of the various component parts has resulted in a good minimum range performance which has been found to be approximately 45 yds.

Transport in Transition

Implications of the British Transport Act

By DAVID R. LAMB, M.Inst.T., President.

In his Presidential Address delivered before the Institute of Transport in London on 18th October, 1948, Mr. David R. Lamb, the newly-elected President of the Institute, reviewed the implications of the British Transport Act. His address deals straightforwardly with the subject, and betraying no political bias, gives a lead for co-operation by all concerned to ensure that the Act becomes a success. For the benefit of our readers, we are reproducing those passages which refer more particularly to the port and coastal shipping industries.

Mr. Lamb first expressed his appreciation of the honour bestowed upon him and then continued:—

This is a period of transition towards "a properly integrated system of public inland transport". The Transport Act of 1947, which provides for public ownership and control of the railways, the canals and long-distance road transport, the eventual adjustment of port administration and the possible establishment of area schemes in respect of passenger transport, is of vital concern to every member of the Institute. Indeed it is destined to affect, for good or ill, the very life of the nation. A great responsibility rests upon those who have undertaken to implement the Act, and in carrying out their difficult task they are entitled to, and should receive, the co-operation of every one of us. At the same time, the methods they adopt in fulfilment of the task must inevitably invite criticism, and so long as this is constructive it will no doubt be welcomed, for those who have accepted this great responsibility desire above all to make the scheme a success, whatever their political convictions.

Whether transport be under private or public ownership, the objects of its administration are the same—to provide an efficient and economical service, to afford fair remuneration to the staff and to yield a reasonable return on the capital invested. But whereas the private concern must aim essentially at the highest possible rewards for its shareholders, the public undertaking must have regard to the general interests of the community. In other words, it has to fulfil communal as well as administrative and technical functions. Thus, the British Transport Act—Section 3 (4)—provides that the Commission shall so conduct the undertakings and levy such charges "as to secure that the revenue of the Commission is not less than suffiicient for making provision for the meeting of charges properly chargeable to revenue, taking one year with another". Moreover, Section 4 (1) states that "the Minister may, after consultation with the Commission; give to the Commission directions of a general character as to the exercise and performance by the Commission of their functions in relation to matters which appear to him to affect the national interest, and the Commission shall give effect to any such directions".

THE NATIONAL INTEREST

The obvious inference is that, whilst the Commission shall enjoy freedom to administer the transport of the country, it is subject always to over-riding direction in the national interest. One of its tasks must therefore be to anticipate or obviate such direction by itself observing the policy of ultimate public need, even though that may not always be to its immediate advantage from a revenue point of view. Services, in themselves unremunerative, may be needed for the development of new industries, satellite towns or sparsely populated areas. Charges schedules must, in principle, be designed to confer equal benefit on all classes of the community. Certain types of transit involving long and unnecessary hauls, remunerative to the transport undertaking but wasteful to the community, may have to be discouraged, as was done by the war-time traffic zoning schemes of the Ministry of Food, but always with the proviso that restrictions on trade must be avoided.

The old adage that transport is the handmaid of industry is admirable so long as it is attuned to modern precepts of domestic service. The Act provides—Section 3 (2)—that "where the Commission are for the time being providing regular goods transport services of different kinds available between the same points, it shall be their duty to allow any person desiring transport for his goods between those points freedom to choose such of the services so provided as he considers most suitable to his needs".

FREEDOM OF CHOICE

This "freedom of choice" is a hard-won privilege of trade and industry, but it pre-supposes an obligation that demands shall be reasonable. Traders, no less than—and perhaps more than—the general public, will benefit from an efficient transport service, and a condition of transport efficiency is that traffic should be guided into its most economical channels. Another condition precedent to freedom is that traders should use with discretion the right to carry their own traffic by road.

Coastwise shipping—an invaluable service in war as in peace—is entitled to its fair share of traffic, and so also are the navigable inland waterways, particularly those providing direct transit from ship to waterside factory and inland distributing depot. But whilst the onus is upon the Commission to provide transport services of a nature and on a scale calculated to benefit the general community, they are entitled to reasonable assistance in fulfilling that object. Highways, for instance, should be of a nature to afford safe and uninterrupted passage to road vehicles in town and country, and the sort of congestion and delay to traffic which now occurs around some of the London markets ought by some means to be overcome.

PORTS

Sections 66-68 of the Transport Act give the Commission wide powers of control over the ports. The Commission are charged with the duty of "keeping the trade harbours under review" with a view to determining whether they shall prepare, in consultation with the interests concerned, schemes for, amongst

Transport in Transition—continued

other things, "constituting or specifying the body or bodies who are to provide port facilities . . . in connection with the harbour or group of harbours". Thus the Act appears to aim at the eventual administration of ports on a regional basis, and it provides that, in preparing a scheme, the Commission shall have regard to the desirability "of providing for the scheme to be administered, as far as may be, from a place at or in the vicinity of the harbour, or one of the harbours in the group of harbours, to which the scheme relates". This proviso is important as it contemplates decentralisation rather than the direct control which characterises the Railway and Road Transport Executives.

Regionalisation of ports is a normal development. It follows the classic example of the Port of London Authority, a trust which was set up in 1908 to acquire and control all the docks on the Thames and its estuary. It is in accord with the suggestion of the Royal Commission on Transport, 1931, and it follows a successful war-time measure. As recently as 1945 a Government Committee reported in favour of grouping, and reorganising under a single control the several ports on the Clyde estuary.

Regionalisation.

During the war, Regional Port Officers were appointed to supervise and co-ordinate the work of groups of ports comprised in defined stretches of coastline. All the larger ports had Port Emergency Committees, representative of the port, shipping, trading and transport interests, an arrangement which, under the direction of Port and Transit Control at Ministry of War Transport headquarters, secured the prompt turn-round of ships and the rapid clearance of traffic from the ports by the best available means of transport.

However, the powers of the Port Emergency Committees over the handling and dispatch of traffic, though essential in war, are inappropriate to the diverse requirements of peace-time business; indeed, the Transport Act, as already mentioned, concedes to the trader his freedom of choice. But if port regionalisation or grouping is contemplated and in due course effected, there should be no difficulty in maintaining regular contact between transport providers and users through the medium of the consultative committees envisaged in Section 6 of the Act.

Regional control should indeed be of general advantage in encouraging the proper provision and distribution of port facilities within regions, whilst the avoidance of competition between neighbouring ports ought to lead eventually to the reduction of port charges. In any group of ports, however, there must be some effective control over the influence of the larger ones so as to secure proper attention to the interests of the smaller ports, which are essential to the coastal shipping industry. The small ports provide ready access and berthing space for the little ships and special facilities for the handling of such bulk traffics as raw sugar from the refineries, seed potatoes from Scotland, grain, timber, cement, coal and china clay. During war-time the small ports around our coast are of inestimable value to the nation; on this account alone, apart from their peace-time purposes, their business should be maintained and encouraged.

Large Ports and Traffic Distribution.

The larger ports, with their vast entrepôt trades, together constitute a vital national asset in peace and in war. Despite their varying types of ownership and control they are efficiently administered, although some of the so-called "customs of the port" are apt to be difficult of interpretation and confusing to shippers and traders, who would benefit by their simplification. Port authorities and the local communities have a right to expect that the ports shall at least be used for traffic to and from their immediate hinterlands, although some of them on the West Coast have been disappointed by the cessation of business which they were required to handle during the war owing to the virulence of enemy activity in the North Sea and the English Channel. In their recent report, the Working Party on the Turn-round of Shipping said:

"The tendency of traffic to concentrate on some ports, while facilities in others are not fully used, merits attention . . . Pressure could be relieved if the burden of traffic through the ports was more widely spread. It is impracticable for us to make any specific recommendation on the method of achieving this result, for the conditions affecting different traffics will vary widely according to source or destination, inland transport facilities, experience and equipment in particular ports, shipping services available and the incidence of cost. Nevertheless, we commend to the consideration of shipowners, and of major importers and exporters, the possibility of saving time by the greater use of ports not at present working to full capacity."

In a study of this kind full consideration must, of course, be paid to inland transport so as to avoid long hauls of large volumes of traffic.

Speaking of this particular working party, one would have liked them in their report to have dealt more realistically with the question of dock labour. Guaranteed wages do not justify the continuance of restrictive practices which jeopardise the business of British ports in face of Continental competition.

COASTWISE SHIPPING

Efficient coastwise shipping is an essential element in the transport system of this island community. Although, for good and sufficient reasons, coastal shipping has not been subjected to State acquisition, the new transport charges structure will have to be so designed as to provide revenue sufficient to maintain an effective and widespread coastal service.

The claims of coastwise shipping for safeguards against unfair competition from inland transport were first admitted by the Legislature in the Railways Act, 1921. Section 39 of this measure gave coastal shipowners the right to make representations to the Minister of Transport in respect of exceptional rates competitive with coastwise shipping, subject, however, to a certain onus of proof that the rates complained of were inadequate in relation to cost of service. Section 39 of the Road and Rail Traffic Act, 1933, also entitled coastwise owners to represent that "agreed charges", designed by the railway companies to meet road competition, placed them at an undue or unfair disadvantage.

These statutory provisions arose out of a recognition by Parliament of the importance of maintaining adequate coastwise services, a consideration which must apply with renewed force as inland transport becomes integrated. Successive Governments have acknowledged the importance of coastal shipping as an essential part of the British mercantile marine and as a necessary, though independent, complement to road and rail. Only last year the present Minister of Transport, in his terms of reference to the Railway Rates Tribunal sitting as the Charges Consultative Committee to advise him as to the level of railway rates, specifically stated that the Committee was "to have regard to the importance of maintaining adequate coastwise shipping services".

Consultation on Charges.

The principle of consultation regarding charges, formerly recognised in agreements between the railway and coastal shipping companies, is now embodied in the Transport Act, which provides safeguards against inland transport competition detrimental to coastwise services. Section 70 provides that the Commission shall have power to enter into agreements with any person engaged in coastal shipping "for facilitating the through carriage of goods, for the quoting of through rates, and for the pooling of receipts or expenses".

Section 71 provides for the setting up of a Coastal Shipping Advisory Committee "for the purpose of considering and from time to time reporting to the Minister on all matters which may jointly affect the interests of the Commission and those of persons engaged in coastal shipping or which the Minister may refer to them for consideration". Then Section 71 (4) provides that:

"If the Committee make a report to the Minister with respect to any matter, the Minister may give to the Com-

(Continued on page 209)

Inland Waterways and their Service to the Ports

A Review of their Present Condition and Future Prospects

By C. T. GARDNER, M.Inst.T.

SOME of the traffic which enters or leaves this country by its sea ports is carried over our inland waterways, and most of them have their special characteristics and features. They are a diverse lot, a mixed bag, made up of navigable rivers, canalised rivers and canals, with no uniformity, no similarity in the size of the craft which they will take, except the "narrow" canals, on which the very small width of barge of 7-ft. maximum, was adopted as the standard.

No doubt, this width was exceedingly useful when the alternative means of transport was the pack-horse, or wheeled traffic on unmetalled roads. On unmetalled roads in Rhodesia the writer found that loaded wagons could not average more than five miles a day in the wet season when pulled by a team of 16 oxen, and one hundred and fifty years ago conditions were not dissimilar in many parts of England. The Fossdyke is probably the oldest canal in this country; it provided a navigable link between the garrison town of Lincoln and the somewhat tortuous River Trent: this route still exists and is used by craft voyaging between Lincoln and Kingston-on-Hull: here sometimes a barge may be seen with a sail set, helped along by a following breeze. In those old times, in spite of the obstacles and dangers of navigation on the Humber, the water route was easier than the land if goods had to be moved in any quantity.

It is not easy now to visualise why the narrow canal owners did not expend money from their profits or raise new capital and largely extend and improve the canal system at the first whisper of railway development, or even earlier, in their own interests: there can be little doubt that the opportunity was there for a big and planned extension: the ports, the mines, manufacturing areas and industry could have been better served than they were, and having this substantial background, the canals would have been more immune, less open to attack by road and rail. Our inland waterway system could have been better, in spite of the lack of enterprise just commented on, if the recommendations of several important bodies had been implemented and if parliamentary enactments in respect of mineral working had been less onerous on the canals: mining subsidence and a retractive policy have been responsible for the abandonment of hundreds of miles of canal: at least 700 miles of canal have been closed to traffic in England and Wales since the report of the Royal Commission in 1908. Though there are exceptions, the condition of the narrow canals, if not all the canals, wide and narrow, has not been materially improved since they were built 150 years ago, when there were no power-driven barges washing the banks into the bottom of the canal.

The narrow canals do not everywhere permit the passage of 7-ft. barges, for a few of them just fail to accept that width because their lock-walls have been pushed inwards an inch or two: the 7-ft. barges sometimes carry 25 tons if power-driven or 30 if "dumb," but these are the upper limits; several canals do not allow enough draft to enable even this small tonnage to be reached: in a dry period these tonnages have to be reduced. The speed of travel varies from 3 m.p.h. to 4½, when loaded, but each lock imposes a delay of about 6 minutes if it is fortunately clear and set the right way when the boat reaches it; the locks are frequently single so that an oncoming boat is obliged to wait if the lock is occupied. A crew of two persons is needed to handle a boat carrying 25 tons, and a total of three persons can handle the power boat and a towed "butty" loaded to 30 tons, totalling 55 tons, when all conditions are favourable. Sometimes, two skilled men will handle the two boats, but their movement is slower and they may do more damage to craft and to locks than the larger crew. It is usually uneconomical to tow a butty if only one boat can lock through at a time, for the delay is too much. On these narrow canals, a small amount of cargo can be moved by two or three persons for a short distance only per day: it is difficult to see how, under such conditions, canal carriers can compete with the highly virile road transport organisations, apart from carrying some exceptional or special traffics.

The revenue of canal companies has been derived from tolls paid by the carriers, though they received other revenue from items such as the sale of water, property rentals, warehousing, etc. The revenue received was in many cases too small to allow the navigation to be properly maintained against the attacks delivered by power-boats; this condition has not been limited to the narrow canals: only rarely were funds spent on deepening or widening the channels or on sheeting the banks from end to end of any erodible material on both sides of the channel; in the result, carriers are sometimes working under adverse conditions, conditions equivalent in railway working to moving goods over an unballasted track, or as though road-hauliers operated on dirt-roads: the canal carrier has all the bias against him, he cannot, under these conditions compete successfully with other well-kept transport systems and the result has been registered by reduced canal traffics and lower receipts, which in turn have resulted in less maintenance until, as a transport unit, the value of the canals has diminished.

The Narrow Canals: No General Increase in Traffic Likely

It seems probable that the question will have to be faced on each narrow canal in turn whether it shall be closed to traffic or be enlarged, straightened and in other ways improved: such reconstruction would be costly and would be opposed: larger barges require more headroom, but places have been observed where railways cross over a canal and cannot be raised higher than their present level so that more headroom cannot be provided.

A Narrow—Boat Canal.

The cost of raising and enlarging tunnels, or of opening them to the sky, might be prohibitive. The canal would probably have to be closed during reconstruction, length by length; it would not be easy to re-capture traffic which would have been diverted to road or rail during the rebuilding; it might never be attracted back. A survey of water resources would have to be made in order to get assurance that there would be enough water for any bigger and busier canal: it would be unwise to spend much money in examining the cost of enlarging any canal before the water supply question had been settled. Most of the water used by a

Inland Waterways—continued

canal is lost by percolation into the ground: some is taken up by the vegetation along the banks: the amount lost by direct evaporation from the surface is small. Water used in passing craft through the locks can be pumped back at small cost. Although care must be taken to avoid forming any conclusion as to the way in which any canal shall be treated until all the aspects of the matter have been explored, the indication seems to be, in most cases, that the opposition would be considerable, the expense very great and the volume of traffic doubtful to an extent which makes any widespread reconstruction improbable.

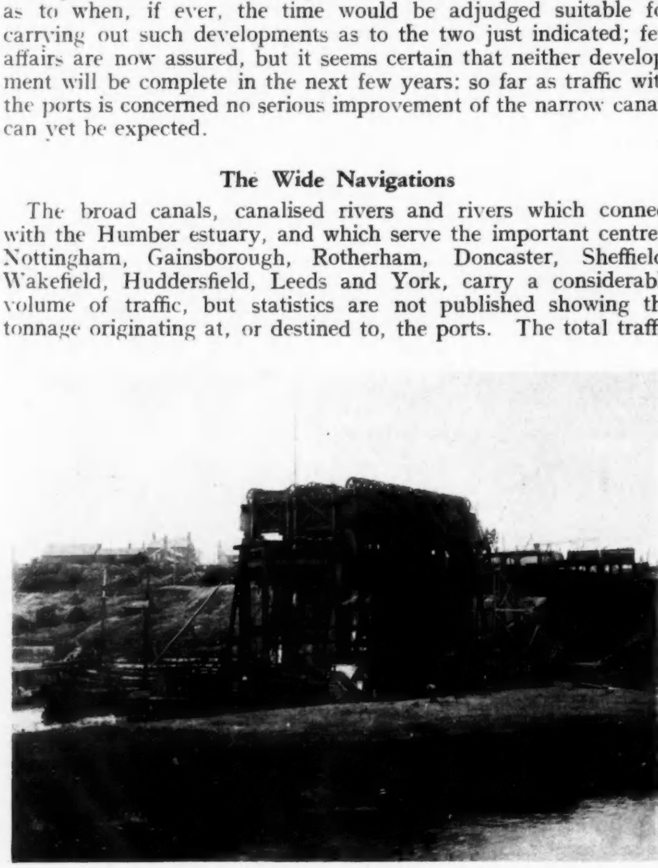
Improvement in the Service to the Midlands Possible

To this statement there is one important exception, that of the Shropshire Union Canal. This canal lies between Wolverhampton and the Mersey. It was constructed by Telford at a comparatively late date on a straighter alignment than other narrow canals. There appears to be no insuperable difficulty in providing enough headroom for 100-ton barges, or even bigger: there seems to be sufficient water for a busy canal. A good canal-head could be established on the outskirts of Wolverhampton and from there goods could be delivered to, or collected from, adjacent industrial areas, by lorry. In essence, the proposal is not at all new, but in the latest form, as suggested by Mr. C. M. Marsh, M.Inst.C.E., it merits, and certainly should receive, close examination. It is no wild flight of imagination to picture a large volume of traffic carried in 100-ton barges between the Midlands and the Mersey. The voyage would occupy not less than 24 hours of moving time if tide and other conditions were favourable.

Another project which has been recently mooted would supplant one of the narrow canals lying to the east of Birmingham and make navigation by 100-ton vessels possible to within a few miles of that city. Political developments of recent years have so upset the equilibrium of this country that it is useless to hazard a guess as to when, if ever, the time would be adjudged suitable for carrying out such developments as to the two just indicated; few affairs are now assured, but it seems certain that neither development will be complete in the next few years: so far as traffic with the ports is concerned no serious improvement of the narrow canals can yet be expected.

The Wide Navigations

The broad canals, canalised rivers and rivers which connect with the Humber estuary, and which serve the important centres, Nottingham, Gainsborough, Rotherham, Doncaster, Sheffield, Wakefield, Huddersfield, Leeds and York, carry a considerable volume of traffic, but statistics are not published showing the tonnage originating at, or destined to, the ports. The total traffic



Anderton Lift, River Weaver Navigation.

which is carried on these navigations is about three-and-a-half million tons annually, of which over two million tons is coal.

The well kept Sheffield Canal does not seem to carry a volume of traffic proportionate to the importance of the cities on its banks; much of the canal is deep and wide, locks are few, except in the top 3 miles entering Sheffield, where there are 12: it has two exits to the Humber, the one via Goole, the other via the River Trent; it serves active collieries: it suffers somewhat from mining subsidence and from floods brought down the River Don. Its craft carry 100 tons: the journey between Sheffield and Hull takes 36 hours. If damage by subsidence can be controlled, this important waterway merits the fullest attention to ensure that it provides the most excellent facilities to the industrial cities in the vicinity for the transport of coal and as a navigation linking them with coastwise and continental shipping.

Across to the west side of the country lies the alkali bearing region of Cheshire: huge industries have been located on the banks of the River Weaver which drains this area; the river has been most efficiently made to serve as a navigation; along it, vessels 140-ft. long and having a draft not over 10-ft. 6-in. operate: its depth is well maintained by dredging, its banks are largely protected, its locks are in duplicate and this allows traffic to continue even if one lock should be under repair. There is adequate wharfage and shed and warehouse accommodation at the lower end, where it adjoins the Manchester Ship Canal. The tonnage conveyed on this river is rather under half-a-million annually, and it is largely for export. It maintains the only barge lift in this country, one which is capable of lifting two narrow barges up some 50-ft. from river level to the Trent and Mersey Canal in a few minutes; china clay, felspar and other minerals pass to the potteries along that canal. It is this River Weaver which, deepened and widened to the south of Winsford would form, in conjunction with the Shropshire Union Canal, the Midland-Mersey route.

Ships of about 3,000 gross tons, having come up the Thames from the Continent or the coalfields can enter the Regent's Dock, which is separated from the river by one lock and discharge their cargo overside into canal barges of some 80-ton deadweight capacity. There is also access to the canal from the Thames near Brentford, through a congested tidal lock followed by a length of over-crowded waterway along which barges are "poked" by hand to the twin Brentford Locks: these two features of congested lock and packed waterway need improvement on a relatively large scale. There is a lot of valuable storage accommodation, both covered and open, at Brentford. The traffic which passes over the Grand Union system is a little over one million tons.

The Lee Navigation, which opens on to the Thames, passes a rather greater volume of traffic; unlike the Grand Union, the Lee has no long distance traffic: its most important traffics have been incoming coal and timber for distribution in the Lee Valley area, which lies to the east of London.

It is fortunate that the non-tidal part of the Thames, above Teddington Lock, has not been developed commercially to any extent; the beauty and pleasure that it provides remain, in a large measure. The Thames Conservancy does its utmost to keep all its works in good fettle, and their appearance in harmony with the surroundings.

The navigable portion of the River Severn is accessible from the Severn Estuary by passing through the Sharpness Docks, the Gloucester and Sharpness Ship Canal, and the Gloucester Docks: in 1946, about three-quarter-of-a-million tons of goods passed along this canal: 400,000 tons passed higher up to destinations on the River Severn, Tewkesbury, Worcester and Stourport. Barges carrying the very useful quantity of 300 tons can reach Worcester. A scheme has been prepared which, if used, will greatly improve the navigation just above Gloucester.

Gradual and progressive growth of trade harbours and adjoining towns has brought about the congestion which is so frequently found in dock areas. Expanding industry takes up a lot of land and, finding the neighbourhood of the port too crowded,

Inland Waterways—continued

it moves further afield, to the outskirts; but though industry which employs shipping for imports of its raw materials, or uses it for export, may have to move to the outskirts, it will settle it possible on a waterway and make use of it for imported goods, or the exportable, as the case may be, so that they can be easily moved between the ocean-going ship and the factory wharf; the factory can take from the river the large quantity of water which is often needed for its processes and return the water to the river after use. Accordingly one may see on the banks of such a river or navigation, timber yards and mills, coal dumps, oil tanks, cement bins, granaries, power stations, waste products for dumping on land or out at sea, including city refuse, boat building and repair yards and all the subsidiary interests which tend to agglomerate around the scenes of major activity.

Cost of Carriage by Waterway

Carrying on the inland waterways was done by large and small companies or by individual owners and to-day there are more than 500 independent carriers. In passing, it is interesting to note that now the Inland Waterways have become nationalised, the newly-constituted Docks and Inland Waterways Executive has also become a carrier. The actual cost of carriage varies considerably with the state of the waterway on which the carrying is done and each lapse from a good standard of maintenance costs the carrier money. The cost of carriage by water is not widely known: bearing in mind that the fuel consumption on a 100-ton barge is less per ton-mile than the consumption by lorry, and that two or three men can handle a cargo of over 100 tons, and that wages are easily the biggest item in the annual cost of either a power-boat or a dumb boat, it appears that fundamentally, the cost of moving goods along a waterway is relatively cheap. The tolls which are levied on the passage of cargo or boat are applied, in the main, to the upkeep of the waterway, that is, the upkeep of reservoirs, feeder channels, the banks of the waterway if it is a canal, dredging, bridges and, on some canals, tunnels, locks and their equipment, weirs, sluices, towpaths where they are used, and hedges: on some lengths of canal the heaviest expenditure is caused by mining subsidence; much thought and good management have been applied in keeping tolls at a moderate figure, though there have been recent increases owing to the decrease in the value of money, but the total cost of traffic by canal is large enough to cast a shadow on the future unless measures are taken to improve the situation.

Conditions Needful for Cheap Conveyance

In order to allow cheapness to be attained certain quite clearly defined conditions must exist; these cannot be too strongly stated, although they may never be fully reached on all waterways. The waterway must be wide enough to avoid congestion and the channel be dredged so as to provide for the easy passing of two vessels: barges tied up at quays or wharves must not foul the fairway. The channel must be deep enough to avoid overmuch "drag." The available headroom should not require any departure from the most suitable design of vessel for carrying the limiting tonnage: the navigation must not be closed for long and unforseen periods by floods or ice, though in this latter case, merchants may have to expect some closure during the winter months and to arrange their stocks accordingly, or if daily transport is essential, provisionally arrange for other transport during freezing periods: the curvature of the waterway should be easy enough for the free movement of the vessel using it; there should be some extra width on curves: the channel must be kept fully dredged and the equipment must be capable of dealing rapidly with channels which have silted as the result of floods: eroding banks must be secured, though not necessarily at the expense of the navigation authorities: locks must be in duplicate. Bridges must not screen craft approaching each other from opposite directions. One or two of these requirements are amplified below.

Carriage Costly on a Shallow Canal; Bad Effects of Drag

A boat does not move easily through a channel which is both narrow and shallow: as the boat moves forward the whole of the displaced water has to flow aft against the resistance of the forward moving boat and that of the bottom and sides of the channel: waves and eddying are the result: the propellor has to work in such a channel under conditions for which it was not designed, and churns the water up; a following wave is created. The waves, or wash, the eddying and the churning are all done at the expense of engine power. Experiments have shown that, considering an ordinary barge of about 100 tons in a fairly wide channel the power consumption mounts up with increasing rapidity as the depth under the barge is reduced from 4-ft. to 2-ft., and the same kind of thing happens as the side clearance—that is, the width between the side of the barge and the canal sheeting—is reduced below 30-ft. assuming that the speed of the boat is about 4 m.p.h.

Coal passing through the Bow Locks, Lee Navigation.

in each case. Under conditions which probably exist on some waterways 80% of the power put out may be wasted: a loss of 50% must be quite frequent: if the cost of fuel averages about 25% of the whole cost of operating a barge, the cost which is directly attributable to drag must be, under the conditions of waterway mentioned above, considerable: this wasteful expenditure falls on the carrier if he does not pass it on to the trader in his freight rates: in either event, it is a deterrent to the use of the waterways. The deeper and wider channel, kept in a satisfactory condition, permits lower rates, and these lower rates must if low enough, not only retain the existing traffic, but attract more, so that, eventually all traffic that can conveniently use the water routes will do so. This is an optimistic statement and outlook one which is much easier written down than it is implemented: it is a statement which, taken at its lowest value, makes quite clear the damaging effects of the shallow channel.

Headroom

The provision of adequate headroom is of importance to the shipowner and to the carrier by barge: works' craft can make use of ample headroom. Headroom is limited by old structures; one low tunnel or one low bridge limits the design and the load of all craft which are to pass. In mining areas subsidence may make the conditions almost impossible, for the water level has to remain at its fixed level in relation to ordnance datum, but the country sinks inches or probably feet, taking with it railways and roadways and thereby reducing the headroom which craft must have; this loss of headroom can usually be restored by regrading the railway or the roadway at a cost which, in the case of a railway is sure to be heavy and which is sometimes very great. At the worst, it will inflict a permanent reduction in the headroom over the canal: barges then must be ballasted down to allow them to pass under the lowered bridge, or cease using the canal.

Low headroom will seriously affect the use of a river by coastwise and continental shipping.

Inland Waterways—continued

All the conditions listed must be observed as well as other more obvious requirements if craft are to be able to move economically over a navigation: it is quite naturally, a long and onerous list. The well-filled navigation is like a belt, delivering a continuous stream of goods, and doing so silently, with freedom from accident, and with regularity: the delay in the delivery of goods compares favourably in some important cases with the railway, and with the road if large quantities of heavy goods, such as coal or timber have to be moved. In the main, lighters and barges will predominate in inland navigation, but some navigations already take small coasters.

Demurrage

Cheap transport by water demands a quick turn-round of the barge, but this does not always happen for a variety of reasons: it may be that the ship which the barge or lighter was to wait on has been delayed: or the coal which was to have been loaded has not been brought to the surface, or a wharf is congested and the barge cannot reach it. In some cases a demurrage charge is raised, but it may be quite small and not enough to cover the cost of the delay: frequently, no charge is raised. Such delay has two unfortunate results; first, the cost of transport is increased, and secondly, carrying capacity is lost; under these circumstances three barges and crews may be needed to do the work of two; even four barges may not succeed in doing what could be done by two. but the cost of the delay does not fall upon the carrier: when no demurrage charge is made it is the trader or merchant who bears the cost of delay, disguised as a carrying cost; there is then no spur to urge him to reduce or avoid delay. Many carriers dislike the idea of raising demurrage charges and fear that if they did the would lose the traffic: there could be no ground for this fear if they will, at the time, indicate a reduction in their true carrying charge to an extent which would leave their total receipts from this traffic unchanged: the situation of the carriers would be improved, for they would be in a position to carry more traffic, they would make a more favourable showing by quoting lower rates in competition with other methods of transport, and the merchant or trader would gain by paying less for the transport. The writer has observed that it is still the custom at some points to discharge coal by hand; it might pay the carrier to have a small number of his power-barges fitted with plant so that he can discharge his own cargo at the cost of the receiver, and keep his barges on the move.

The Ideal Size of Craft and of Canal

The question of the size of barge that should be employed is one that is influenced by many considerations. On a big river, such as exists on the Continent and elsewhere, or on lacustrine navigation, there may really be no limitation except that of convenience. A canal invites a barge that is long, shallow and narrow, but there are structural limits to the ratios of these dimensions which cannot be exceeded especially if the craft may ever have to voyage along an estuary or other exposed water. If it takes much longer to load and discharge a large barge than a small one, much or all of the saving in crew brought about by employing a large barge is cancelled; the handling facilities which exist or are likely to be brought into operation affect this matter. The trader may prefer a steady flow rather than a more occasional big consignment, and the same consideration may affect the wharfinger: of all these considerations the predominant one so far is that of giving satisfaction to all the needs of the trader. The ideal size of barge governs the size which the navigable channel should be: if a new canal were under investigation, or an enlargement, the two factors of size of barge and size of channel, would have to be examined in conjunction. The most efficient canal is clearly one which will be most continuously in use: for example, a canal passing one big barge daily would be less economical than a canal of smaller cross-sectional area passing an equal tonnage with the same freedom from drag, in two or three daily barges. The ideal size for an economic canal is one which would have and permit a steady flow of vessels without congestion; they would be equally spaced out so that one vessel would reach a lock as soon as the lock could be made ready to receive it, and this would be one vessel each 10 to 15 minutes: they would move at a speed insufficient to damage the sheeted sides, or the bottom. The canal would thus require the minimum of tolls for its upkeep, and this minimum would be reflected in the rates chargeable against the trader.

The object of the three parties, trader, carrier and waterway authority should be to get the cost of tolls plus carriage plus terminal delay to a minimum.

These diverse factors and conflicting requirements indicate that the very large barge is only economic where the traffic is heavy and the lead long. It seems as though one hundred tons is the minimum capacity that is desirable for economic operation on canals in this country. Fluvial barges are relieved of a part of the restriction imposed by the cost of cutting or enlarging an artificial canal, and will accordingly be built larger than those which have to enter restricted channels.

Adaptation of Inland Waterways to Take Ships Unlikely

The possibility of the economic improvement of rivers to take coasting vessels, cross-channel craft, or Continental shipping deserves a moment's thought. The line of approach to a grasp of the governing considerations is similar to that which has just been stated, substituting the word river for canal in each case in which the river has to be largely improved to make it suitable in every respect for navigation by ships. A poor river navigation would never compete with discharge at the seaport and rail service. A good river navigation, complying with all the conditions mentioned in this article would be costly both to make and to maintain. Shipping requires a lot of air-clearance; a type of ship voyaging between this country and the Continent needs 80-ft., but it is impossible to provide that headroom at any acceptable cost at each of the numerous road and rail crossings over any river which might possibly be made navigable by ships. The alternative to the practical impossibility of providing headroom lies in providing lowering masts. The attraction of a river navigation to a shipowner is so slender that, if he has to design his ship to conform to the needs of the navigation, such as telescopic masts, shallow draft, etc., etc., he will be unable to compete with others who keep to the blue water: he would not use the waterway even if it were provided. It is improbable that any up-river terminal will be be developed for use by ships.

Need for an Advisory Service

Carriers by water have not got an advisory service although there are many subjects of value to them which can only be handled or sifted by capable technicians: the work of the National Physical Laboratory, in so far as it affects water carriage, should be brought into view: the most economic form of channel in regard to barge shape and resistance, barge lines, propellor design, materials and their preservation, lubrication, silting of channels are amongst the subjects which are studied at that laboratory. Some of the matters which are from time to time brought before the Institution of Naval Architects are of concern to the carriers. New forms of both cargo handling plant and engineering plant appear on the market: on the Continental waterways, where conditions are less static than in England, there is continual progress, and information should be made available to the carriers. Carriers have not got their own periodical and no periodical regularly gives space to them, yet consideration suggests that there is a large crop waiting to be harvested and, after putting through the mills, it should be served up in many vitalising meals. Periodicals could give news of schemes and projects affecting the waterways and their proximate industries, of alterations to the waterways, such as changes in depth, dredging progress, alteration to wharves, and to plant; and so on: news of drought and of floods and measures taken to alleviate the results: news of personnel, of the Executive and their deliberations; changes in regulations, and in bye-laws; closure of canals, launchings of new vessels, improvements in repair yards, fire precautions in warehouses and elsewhere, pilferage, policing, insurance, traffic statistics, tolls and freight rates, cullings from the Continent: verily, a periodical embracing these and other features and all their off-shoots, as space

Inland Waterways—continued

permitted, would be more than a meal, it would form a mine from which knowledge and profitable information could be drawn.

The Question of Exceptionally Low Rail-Rates

Whilst it would be easy to take a decision in regard to the retention or abandonment of some waterways it will, in some cases be difficult to form an opinion based only on past experience.

Transhipping cargo from large barge to small canal boat at Leeds.

The cost of carriage by water can be ascertained under certain given conditions with considerable exactness, and the cost can be broken down into its components. The cost of carriage by rail is much more nebulous, but the British Transport Commission may wish to consider whether the exceptional rates which have been so hurtful to water transport, should continue: strangely enough, the Commission seems to have been given power to break a carrier on the water, without compensation, and some such misfortune might occur if the machinery of the law moved quicker than the spirit of the Executive, assuming that so heavy a machine can continue to renew the spirit left to it since the bodies of the undertakers, as the authorities for many of the canals were called have been decomposed. It is however unlikely that the B.T.C. will do anything which is calculated to injure the carrier who provides a good service at a reasonable figure; more probably that commission will gradually annul those rail rates which are unduly low, and will not unsheath the weapon of rates if the carriers show moderation and efficiency; further, it is unlikely that the B.T.C. will neglect the promotion of measures which will permit carriers to produce a yet better service.

River Boards and Navigation

The main function of a river is that of carrying a portion of the rainfall into the sea or an estuary; it drains the land of a proportion of the normal rainfall, and of flood water. A river is not naturally straight; it meanders according to laws which have been to some extent ascertained; if straightened it would resume its wanderings unless it is confined. A drainage authority would like its river to have a deep and wide bed and a fairly straight course so that the flood waters can be got rid of without delay but not at such a fast speed that the lower country would be inundated. Navigation also needs a deep bed and freedom from sharp bends but in addition it requires some impounding of the water; this is done by weirs which may or may not be sluiced; it is of value to note that a well-designed weir, having no sluices has no effect in retarding a major flood provided the depth of water over-topping the weir is not less than the height of the weir above river bed; the water will then flow over the weir with such an unbroken surface that there is little to indicate the presence of the weir; if weirs are sluiced, lesser floods can be passed without being impeded or headed up. Good drainage and navigation are not incompatible; there should be little difficulty in harmonising land drainage and storm water disposal with the needs of navigation; navigation has in the past paid for a lot of dredging of the the navigable waterways and for much of the bank protection; on balance it appears that navigation is more of a help to clear floods than it is a hindrance: the two functions are complementary and representation and co-operation should be provided for in the River Boards Act.

Coast Protection Bill

The text of the Coast Protection Bill, introduced in the House of Lords by Lord Shepherd, on behalf of the Minister of Health, Mr. Aneurin Bevan, and the Secretary of State for Scotland, Mr. Arthur Woodburn, was published during the middle of last month. In brief, the Bill increases the powers of public authorities to deal with coast protection problems and will throw on the Minister of Health and Secretary of State for Scotland a responsibility for co-ordinating sea-defence measures in many cases where a variety of interests is concerned; it will not, however, take away coast protection duties from those who already have them. While the present shortage of labour and materials exists, only the most urgent sea defence works can be undertaken.

Local Authorities.—The local coast protection authorities will be the County Borough and County District Councils (i.e., Borough, Urban District, and Rural District Councils) except where a Joint Board is formed to deal with a coast protection problem affecting a variety of interests. (Clause 1).

These authorities will have power to carry out work for the protection not only of their own land, but of any land in their area. (Clause 4).

Subsidy.—As this is a costly form of engineering, there will be an Exchequer subsidy which will vary according to the size of the work, the financial strength of the authority and other relevant factors. (Clause 19).

Compulsory Powers.—Compulsory powers will be available, where necessary works would not be possible without them, e.g., owing to restrictive covenants or the unwillingness of landowners to permit access or contribute in respect of the benefit they will receive from the work. Any person with an interest in land which will be protected may be asked for a contribution (called a "coast protection charge") but this will be limited to the enhancement in the value of their interest which the carrying out of the work causes. A series of provisions aims at holding the balance fairly in such cases between the public interest and the rights of the individual. (Clauses 6-11).

Coast protection authorities are also enabled, where the state of the coast warrants it, to control any new development on the seashore which might cause erosion (Clause 17), or to prohibit the removal of beach material, subject to conditions and licences. (Clause 20). Such prohibition will require Ministerial consent and be subject in certain cases to parliamentary procedure.

Safety of Navigation.—The opportunity is taken in this Bill of giving the Minister of Transport a definite power to restrict any works below high water mark, or to order the removal of abandoned works, if this is necessary for the safety of navigation. (Clauses 29-31).

Crown Foreshore.—Statutory authority is also given in the Bill for an arrangement which is already working on an agency basis, viz., the transfer to the Commissioners of Crown Lands, as from an Appointed Day, of the function of managing such Crown foreshore as is still formally under the control of the Minister of Transport. (Clauses 32-35).

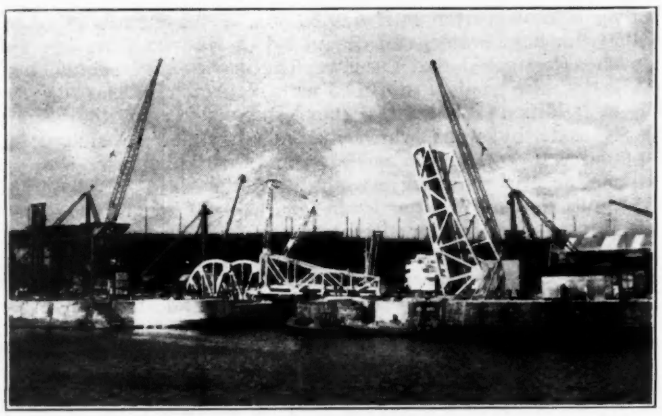
Estimated Expenditure under the Bill is tentative, but coast protection authorities may, it is thought, undertake schemes costing up to half-a-million or a million pounds per annum in the aggregate, during the first few years after the Bill is passed. The Exchequer grant may amount to something like half of this.

New Bridge at Sunderland

First Aluminium Alloy Bascule Bridge in the World

On Friday, 26th November last, the first aluminium alloy bascule bridge in the world was opened at the Port of Sunderland, by the Minister of Transport, the Rt. Hon. A. J. Barnes, M.P. A few minutes earlier, Sir Guy Wrightson, Chairman of Head, Wrightson & Co., Ltd., the builders of the bridge, had formally handed it over to Sir Frank Nicholson, Chairman of the River Wear Commissioners, the Port Authorities. The actual ceremony of opening was performed by the Minister by lifting and lowering the bridge and by cutting an aluminium tape stretched across the bridge roadway.

Two factors made this event of immediate importance, one national, one technical: its relation to the country's export drive and the use, for the first time, of aluminium alloys in the construction of this type of bridge. As an engineering project this is certainly one of the great achievements of the day.



View of bridge with west leaf being erected.

The new bridge spans the junction between the Hudson and Hendon Docks which is being widened as part of the Port of Sunderland Improvement programme. Primary responsibility for the detailed design and execution of the work rests with the Commissioners' Engineer, Mr. W. H. S. Tripp, M.Inst.C.E., M.I.Mech.E., whose skilful planning ensured that the normal services provided by the port would not be interrupted by the work in progress. A feature of the Hendon Junction scheme was the short period required for erection of the bridge and the contract specified that the waterway should never be closed if required for the passage of a ship.

Because of the light weight of the aluminium alloy structure, Messrs. Head, Wrightson were able to construct the movable spans at Thornaby-on-Tees, and float them by motor ship to the site. Construction at the works was finished on August 30th and the first leaf reached Hendon Dock on September 12th. In one month from then the erection of both leaves was completed. The designer of the superstructure of the bridge is Mr. F. J. Walker, A.M.I.C.E., A.M.I.Mech.E., who, until April, 1946, was the Chief Civil Engineer of Head, Wrightson & Co., Ltd., having been with the Company for over 40 years. Just over two years ago, Mr. Walker became Director and General Manager of Head, Wrightson Light Alloy Structures, Limited, and established an office in London for research into the possibilities of building structures of aluminium alloys.

Description of Bridge

Structure details. The bridge is of the double leaf trunnion bascule type designed to carry road and rail traffic, and the whole of the movable span with the exception of the kentledge boxes, rails, and other small details, are fabricated in aluminium alloy in order to reduce as far as possible the weight to be moved. The moving spans are about 40% of the weight of an equivalent steel structure. The fixed approach and foundation girders are of mild steel, since there is no advantage to be gained by departing from standard practice for this portion of the bridge. The dimensions of the bridge are:—

Clear opening to dock	90-ft. 0-in.
Centres of trunnion bearings	121-ft. $1\frac{1}{2}$-in.
Centres of Main trusses	19-ft. 9-in.
Clear width of roadway and footways	18-ft. 6-in.
Rail level to high water at ordinary spring tides	9-ft. 6-in.
Radius of quadrant on main girder ...	19-ft. $6\frac{1}{4}$-in.

Movable Span. This consists of a roadway 9-ft. wide between kerbs and two footpaths, each 4-ft. 9-in. wide, together with a standard gauge railway track. The rail bearers are of plate girder construction, 2-ft. deep and the cross girders are spaced at 13-ft. centres and are 2-ft. $11\frac{9}{16}$-in. deep.

The roadway flooring consists of aluminium alloy plates on longitudinal channel bearers and the surfacing is asphalte bonded to the plating by expanded metal. Special attention has been paid to the junction of the two leaves, at this point the rails have scarfed joints to minimise hammer blow, together with cast steel wheel guards, the whole being arranged to allow for expansion and contraction due to variations of temperature.

Main Girders. the forward end of the main girders are of lattice girder construction. The top boom is composed of two channels battened together at intervals, and the lower boom of two channels with a flange plate extending from the trunnion to the panel immediately beyond the forward bearing. The vertical and diagonal members are of I-section built up from plates and angles.

The tail or quadrant end of the girders has the top boom curved to a radius of 19-ft. $6\frac{1}{4}$-in. The boom is composed of two cheek plates with 4 flanged angles and a top flange plate. There are two angles rivetted on the top to which the pins forming the rack are fitted.

The ballast boxes are of mild steel, filled with burr concrete, and cast iron blocks are provided for final adjustment.

The new bridge nearing completion.

The maximum loads for which the bridge is designed are those of a 70-ton bogey on two axles or a train of 15-ton axle loads at 10-ft. centres for the railway and a 75-ton trailer on two 4-wheel axles for the roadway The footways are rated at 56 lb./ft.^{2}

The plates and extruded sections for the bridge are supplied by two of the leading producers of aluminium and its alloys in the United Kingdom: the British Aluminium Company, Limited, and

New Bridge at Sunderland—continued

Northern Aluminium Company, Limited. Altogether, some 17 tons of plates and 34½ tons of extruded sections were supplied.

The plates supplied are of aluminium alloy with an ultimate tensile stress of 25 tons per sq. in. and proof stress of 15 tons per sq. in., the largest plate size being 18-ft. 6-in. x 3-ft. x ½-in.

Extruded sections are of aluminium alloy with the same tensile properties as the plate; one of the larger sections is a 12-in. x 4-in. channel section weighing 12.79 lb./ft.

The total weight of aluminium alloy used in the movable span is 51½ tons.

Control Mechanism. The machinery for operating the bridge is placed below ground level, where a pinion engages with a curved pin type rack at the tail end of each truss. When the bridge is opened, the curved tail ends of the trusses descend into water-tight pits in the abutments. The pits are spanned by the approach girders and flooring.

Each leaf is operated through reduction gears by two motors, but in the event of one motor failing whilst raising the bridge, the other can continue the operation quite safely. The machinery is designed to raise and hold the bridge against a wind pressure of 15 lbs. per sq. ft.

When in the "down" position the leaves are locked to each other by two robust steel bolts which ensure that the leaves deflect together, as a load passes over the bridge. The bolts are driven by a motor through gears and are controlled from the master controller through a limit switch. The longitudinal camber is $2\frac{7}{16}$-in. between trunnions.

The bridge is controlled by a master drum controller operating relays, and beyond this everything is automatic. The bridge operator controls the bridge from a control house, and a luminous indicator is provided which shows all positions of the bridge. Navigation lights are also fitted to each side of the East Leaf, and traffic lights are installed and inter-locked with the bridge controls to show green when the bridge is open to road traffic, and red when it is being raised or is open to shipping.

Transport in Transition

(Continued from page 202)

mission such directions as he thinks fit regarding the exercise of the Commission's powers with respect to that matter (being directions which, in his opinion, it is necessary that he should give for securing that efficient coastal shipping services are maintained to the extent which he considers is required in the national interest), and the Commission shall give effect to any such directions".

Other safeguards are provided in the Act for this arm of Transport.

Unfortunately, the fact that its operating costs have increased in greater proportion than those of inland transport renders all the more difficult an adjustment of charges designed to reduce competition. If coastwise freights had increased during the war in ratio to operating costs, with the railway rates continuing at only 16⅔ per cent. above pre-war, shipping freights would have reached a level totally uncompetitive with railway rates, and traffic would have suffered diversion to the railways. Certain factors, however, operated to prevent this. The coastwise services, like the railways, were carrying a large volume of Government traffic and of Government-sponsored traffic, and as the national interest required that every form of transport should be used to the best advantage, the Government departments responsible for the movement of supplies directed goods coastwise whenever it was convenient to do so; to the extent that this process has been continued, coastwise rates are being subsidised.

Sooner or later these rates will have to find their economic level and the responsibility for seeing that they do so must largely fall upon the Coastal Shipping Advisory Committee, which will be the medium of contact between the coastal shipping companies and the Transport Commission.

Notable Port Personalities

No. LIX.—Sir John Richard Hobhouse, M.C.

Sir John Richard Hobhouse has been elected Chairman of the National Association of Port Employers in succession to Mr. Colin Anderson and will assume his duties on 1st January next.

Mr. Hobhouse was born in February, 1893, the third son of the Rt. Hon. Henry Hobhouse of the well-known Somerset family, and Margaret Potter, a sister of Mrs. Sydney Webb. He was a King's Scholar at Eton, and went for a year to New College, Oxford, before going into the business of Alfred Holt & Co., Shipowners, of Liverpool. He served with the R.G.A. in France in World War I, winning the M.C. and attaining the rank of Captain. After eighteen months as Director of Alfred Holt & Co.'s agents in Singapore, he returned to Liverpool, where he became a partner in 1920.

Sir John R. Hobhouse, M.C.
(Chairman of the National Association of Port Employers).

He has been closely connected with labour matters throughout his career, through the Employers' Association of the Port of Liverpool, of which he is at present Chairman. He was for many years a member of the National Maritime Board.

He was Chairman of the Liverpool Steamship Owners' Association in 1941-43, and also Chairman of the General Council of British Shipping in 1942-43, in the formation of which he had taken a leading part.

He has been Treasurer of the University of Liverpool since 1942, and this year has been elected President of Council and Pro Chancellor. He is a Justice of the Peace for Liverpool and has taken an especial interest in the work of the Juvenile Court.

At the start of the second World War, Mr. Hobhouse was appointed Deputy Regional Commissioner for the N.W. Region, a post he held for nearly a year, after which he returned to Liverpool and became N.W. Regional Representative for the Ministry of Shipping, and subsequently the Regional Shipping Representative for the Ministry of War Transport until the conclusion of hostilities and the end of shipping controls.

Notes of the Month

New Oil Installations for the Port of Antwerp.

As part of the industrial re-equipment of Belgium under the European Recovery Programme it has been provisionally agreed that an oil harbour and oil refinery with a capacity of 1,000,000 tons a year will be built at Antwerp.

Increased Income at Port of Southampton.

A statement of the Southampton Harbour Board's income for the nine months ended September 30th, showed a total income of £130,783, an increase of £25,224 over the comparable period of 1947. In the same period, expenditure at £89,130, was £11,543 greater than in 1947.

Rehabilitation in Greece.

The smaller of the two dry docks at the Port of Athens destroyed by the Germans during their evacuation from Greece has been reconstructed. The Corinth Canal, which was also destroyed by the Germans, has been reconstructed and small vessels are now able to use it. Larger vessels will also be able to use it when minor work now in hand is completed.

Winter Navigation to Helsingfors.

Shipping circles in Finland are expecting that the Russian closing of Porkala area will be continued. This will mean that regular winter traffic will not be able to make use of the Port of Helsingfors but will have to use Hango, Abo, Raumo and Bjorneborg, unless the winter is exceptionally mild. In order to ease the position, the Gulf of Bothnia ports, from Kristinestad northwards, will be kept open as long as possible.

More Closed Sheds for Hull Docks.

In the general interest of the trade of the port, and for the greater protection and safeguarding of goods in transit, five open sheds at Hull Docks are to be converted into closed lock-up premises and the lighting in them improved. The buildings to be reconstructed are Transit Sheds Nos. 19, 20 and 21, at Albert Dock, and No. 29 at William Wright Dock, all mainly accommodating general cargoes carried in vessels in regular service with Iceland, Sweden, Poland and other Continental ports. The work will be carried out by the Departments of the Chief Engineer for Docks and Chief Mechanical Engineer, and the cost will be about £10,000.

New Transit Sheds for Mersey Docks.

The erection of three new transit sheds, two at Liverpool and one at Birkenhead, was decided upon by the Mersey Docks and Harbour Board at its meeting held early last month. They will be single-storey structures, complete with roadways, dockside cranes and rail and crane tracks, and will be sited at North Side Alexandra Branch No. 3 Dock, North Side Canada Branch No. 1 Dock and at Grandidges Quay, West Float, Birkenhead. The estimated costs will be £600,000, £220,000 and £207,500 respectively. The two new sheds at Liverpool are to replace accommodation damaged by enemy action, while that at Grandidges Quay is planned to alleviate an acute shortage of outward loading berths at Birkenhead.

Seven-Mile Pier in Persian Gulf.

It was recently announced that Great Britain has secured a $5,000,000 contract in Saudi-Arabia for the Arabian American Oil Company, which is controlled wholly by American interests. The work embraces the construction of a causeway and pier carrying a broad-gauge railway, seven miles long, into the Persian Gulf, and will be used for berthing vessels supplying the new oilfields now being developed at and around Dhahran. The pier, which is expected to take 12 months to complete, will probably be the longest in the world. The contract for the causeway and pier is being undertaken by a London firm, John Howard & Co., Ltd., and payment will be made in dollars. The Contractors have bought a large tank-landing craft, which is being fitted with equipment for carrying out the work expeditiously. In addition all plant is to be provided from the United Kingdom.

Grain Shipments from Canada.

Canada expects to ship a total of 6,500,000 bushels of grain to Britain before ice closes the Great Lakes' navigation season some time this month. About half this grain is already in transit by ship, while heavy rail movements of grain eastward are helping shippers to meet their objectives.

Port of Albany to be Developed.

Improvements to the existing port facilities at the Port of Albany, at a cost of approximately £50,000 and other new projects costing a further £700,000 have been approved by the Government of Western Australia. The plans which have been prepared by F. W. E. Tydeman, formerly consultant to the Singapore Harbour Board, provided for two new berths on a marginal layout system, transit sheds, road access and marshalling yards. An area of 64 acres will also have to be reclaimed. Because of insufficient port facilities only about 11,000 tons of exports per annum is at present shipped through Albany.

Increased Mechanisation in United Kingdom Ports.

The Minister of Transport, the Rt. Hon. Alfred Barnes, M.P., has set up a small expert Working Party to investigate the possibilities of increased mechanisation in U.K. ports, with special attention to the handling of timber imports. This important aspect of port facilities was dealt with extensively in the report of a previous Working Party set up by the Minister to assist in improving the turn-round of shipping, which recommended a comprehensive review of mechanisation possibilities in home ports and a study of mechanisation practices in foreign ports. The Working Party will have its first meeting at an early date.

Rhine Traffic Route to be Re-opened.

It has been officially announced in Frankfurt, that the pre-war international railway route through Europe on the right bank of the Rhine, will be reopened for commercial traffic on March 1st, 1949, and will be available to goods traffic between Britain and the Low Countries, Switzerland, Italy and beyond. This route has been closed to such traffic, with a few exceptions, since the end of the war. It is regarded as a speedy means for goods transport for certain areas in Britain and from Holland. Both Holland and Belgium will have the advantage of only one intermediate Customs point at the German frontier.

Transport Consultative Committees.

The Rt. Hon. Alfred Barnes, M.P., Minister of Transport, has appointed Major Egbert Cadbury, D.S.C., D.F.C., M.Inst.T., J.P., to be Chairman of the Central Transport Consultative Committee for Great Britain to be established under the Transport Act, 1947. He has also appointed Mr. Neil S. Beaton, J.P., and Lt.-Col. H. Edmund Davies, K.C., to be Chairmen of the Transport Users Consultative Committees for Scotland and Wales respectively, and they will also be members of the Central Transport Consultative Committee. The Minister also expects to announce shortly the full composition of the Central Transport Consultative Committee.

New Indian Port.

The Government of India is planning a large new port at Kandla on the South Coast of the Island of Cutch, North of Bombay. At present the two chief ports on the Western Coast of the Indian Peninsular are Bombay and Karachi, but since Karachi has become the capital of the separate Dominion of Pakistan, India has felt the need of a second seaport on her western shores. Accordingly, a committee was appointed by the Indian Government to find a suitable site, and they have decided on Kandla, on the Gulf of Cutch, where there is a natural deep-water harbour and plenty of vacant land nearby for the development of port facilities. The proposed port lies about 200 miles south-east of Karachi, and some 300 miles north of Bombay.